

PROCEEDINGS OF THE 36th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

**Park City, Utah
September 1988**



Proceedings of the 36th Annual Western International Forest Disease Work Conference

**Park City, Utah
September 1988**

**Compiled by:
Bart J. van der Kamp
Faculty of Forestry
University of British Columbia
Vancouver, British Columbia**

Compiled by Bart J. van der Kamp
TABLE OF CONTENTS

Page

1	Chairperson's Welcome	J. W. Byler
3	Keynote Address	Dale N. Bosworth
7	In Memoriam: Clarence R. Quick	

PANEL: DIVERSE PERSPECTIVES ON DISEASE AND PATHOLOGISTS

8	Views From a Wildlife Ecologist	Winifred B. Sidle
9	How Economics Can Contribute to the Applicability of Forest Pathology Research	Stephen E. Daniels
12	Incorporating Pest Management into Land Management Decisions	Borys M. Tkacz
15	Diverse Perspectives on Disease and Pathologists : view from a Wildlife Biologist	John Schwandt
17	Hazard Tree/Vegetation Management Panel Update	James T. Hoffman
18	The Role of Forest Pathologist in the Urban Forest	Kenelm W. Russell
26	Hazard Tree Management in British Columbia	J. Muir and K. Joy

PANEL: MISTLETOE CONTROL WITH ETHEPON

29	Mistletoe Control with Ethepon	Frank G. Hawksworth and David W. Johnson
32	Chemistry, Mode of Action, Safety, Uses, and Registration Status of Ethepon for Dwarf Mistletoes	Thomas E. Vrabel
34	Ethepon Tests for Lodgepole Pine Dwarf Mistletoes in Colorado	Thomas H. Nicholls
37	Ethepon Tests for Ponderosa Pine Dwarf Mistletoe in Colorado	David W. Johnson and Diane M. Hildebrand
39	Ethepon Tests for Ponderosa Pine Dwarf Mistletoe In New Mexico	Jerome S. Beatty, Helen Maffei, Edward Collins and Monty Christian
40	Ethepon Tests for Douglas-Fir, Larch, and Ponderosa Pine Dwarf Mistletoes in the Northwest	Catherine Parks and James T. Hoffman
41	Ethepon Tests for Dwarf Mistletoes in California	Susan Frankel and David Adams
42	Control of Leafy Mistletoe (<i>Phoradendron tomentosum</i>) with Ethepon	Ann Marie Wiese
44	Mistletoe Control With Ethepon Conclusions	David W. Johnson and Frank G. Hawksworth

PANEL: PUBLIC INVOLVEMENT IN FOREST HEALTH - WHO WILL SPEAK?

46	Public Involvement in Forest Health - Who Will Speak?	John G. Laut
51	Public Involvement in Forest Health - An Academic Perspective	Dick Parmeter
55	Public Involvement in Forest Health -a Forest Pest Management Perspective	Dave Holland
58	Public Involvement in Forest Health - a Forest Pathology Research Perspective	Ed F. Wicker

PANEL: SPECIAL PRESENTATIONS

- 68 Annosus Root Disease in Western Hemlock 20 Years After Treating Stumps with Borax During
Precommercial Thinning
David C. Shaw, Robert L. Edmonds, Charles H. Driver, Kenelm W. Russell and Willis R. Little
- 73 The Development of a Risk Rating System for Comandra Rust in Lodgepole Pine
Jane E. Boyd and William R. Jacobi
- 78 The Effect of Environmental Stress on Cytospora Canker of Aspen
John C. Guyon II, William R. Jacobi and Gary A. McIntyre
- 82 Armillaria in Some New Zealand Second Rotation Pine Stand Martin MacKenzie and Nicholas M. Self
- 88 Changes in the Incidence of Dwarf Mistletoe Over 30 Years In the Southwest
Helen Maffei and Jerome Beatty
- 91 Forest Management in California State Parks Mark E. Schultz
- 95 Evidence of Variability in Pathogenicity Among Isolates From an Isozymically Monomorphic
Population of Western Gall Rust M. M. Chen, F. W. Cobb Jr., W. J. Libby and D. R. Vogler

BUSINESS AND COMMITTEE REPORTS

- 107 Dwarf Mistletoe Committee Report
- 113 Disease Control Committee 1988 Investigations
- 119 Rust Committee Report
- 120 Root Disease Committee Report
- 122 Business Meeting Minutes and Treasurer's Report
- 125 Field Trip
- 127 WIFDWC Projects
- 135 Publications: 1987-1988

Chairpersons Welcome

I am pleased to welcome you to the 36th annual Western International Forest Disease Work Conference!

The first thing I wish to do is recognize several people who have donated considerable time and effort to WIFDWC during this past year:

- Fred Baker is in charge of local arrangements. The accommodations are first class.
- John Pronos is program chairperson. The program promises to stimulate lively discussion.
- Greg DeNitto was last year's secretary. He not only published the proceedings in good time, but he has agreed to take notes for Bart Van Der Camp, our current secretary, who is unable to attend.
- Walt Thies has agreed to serve as WIFDWC photographer. Please cooperate with him. He has been asked to get candid shots.

Next year's conference will be a joint meeting with the Western Forest Insect Work Conference. It is scheduled for Inn of the Seventh Mountain near Bend, Oregon. Alan Kanaski is making local arrangements. Don Goheen is soliciting suggestions for the program.

Before we go on, I'd like you to stand for a moment of silence in memorium for two of our members who passed away during the past year, Phil Thomas and Clarence Quick. Phil was a pathologist with the Canadian Forest Service and served as director of the Pacific Research Center. Clarence was a research scientist in the Pacific Southwest Forest and Range Experiment Station of the Forest Service.

It is customary for someone in my position to offer words of wisdom or a perspective on WIFDWC. During recent years, we have undergone some introspection as a society of forest pathologists. What have been our successes and reasons for our failures? Such discussions promise to be part of this year's program. I'd like to offer a few ideas thought as we begin our deliberations:

1. Back in the mid-sixties soon after I arrived at Berkeley, Fields Cobb impressed me with the concept that "plant pathology is an applied science, and forest pathologists have the responsibility to serve society--to solve real, economically important forestry problems." I believe it is important for us to keep in mind who our clients are--and what our clients needs are for information. We need to continually ask ourselves how we can produce and apply more usable information on technology.

2. A second idea that I'd like to suggest is the concept (not necessarily a new one) that forest diseases are better prevented than treated. The medical profession has become increasingly aware of this in recent years. We forest pathologists are sometimes apologetic because we have developed few disease cures. But we can and to a large degree already have changed the way forests

are managed. There has been a major change in the past 10-15 years in the degree to which insect and disease treatments are built into the silvicultural process.

3. Finally, I'd like to end with a quotation (maybe not an exact quotation) of another professor of mine, Dick Permeter. The thought is something like "we can and should have a good time doing the things we take seriously."

So--welcome to WIFDWC and have a good time.

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Dale N. Bosworth

Welcome to Utah!

Utah's National Forests are probably the most diverse in the U.S. Within the six National Forests in Utah, lands range from redrock canyons to alpine mountain wilderness, white water rivers to large reservoirs and Great Basin Desert. Timber, minerals, oil and gas, wildlife and fish, livestock forage, water and recreation are all plentiful in Utah's National Forests. Here in Park City we are within an hour's drive of more than a million people. In fact the Wasatch-Cache NF is one of the heaviest-used forests for recreation in the United States.

People in Utah are attached to the land. They use their National Forests. They care about how they are managed and they take an active interest in assuring wise use of the forests. They care about the health and well being of their public lands.

I think people everywhere care about the health of the public lands. The problem is, there are many different opinions about what a healthy forest is and how to achieve it. I think pathologists have the same problem public land managers do--we have a tendency to assert our personal values onto the public. We tend to think that if only the public were educated then they would believe as I do. All too often our public involvement efforts are really efforts to convince the public that they should see the rightness of our ways rather than to seriously try to understand their desires.

We found out just how much the public cared about National Forest lands during our massive forest planning effort started some 10 years ago. That taught us a lot about the land, the resources and the public desires. One important result of planning was the identification of the "Desired Future Condition" for each parcel of land. Unfortunately, in many cases the Desired Future Condition identified cannot be achieved within the stated standards and guidelines.

Why? One problem was the lack of involvement by specialists--our pathologists and entomologists. The tendency was to criticize after the fact. It was also partly the fault of planners and managers, for not aggressively seeking help from the scientific community. We needed your involvement and expertise in analyzing the consequences of different land management options.

The fact remains that pathologists need to expand beyond the closed circle of forest disease and into the area of public land management. Forest Plans are as much a social document as they are a biological document. People's values and lifestyles need to be considered and incorporated into them. And equally important, the results must be achievable both scientifically and socially. My experience has been that many pathologists want to stay at arms' length from social and economic factors.

You seem to believe there is only one right way to manage a piece of land and you are in search of that one right way. The fact is there are many right ways to manage a piece of land and also some wrong ways. Right and wrong is often

defined by the basic values of the individual. For example a person who values wilderness and natural systems might believe that man cannot improve upon mother nature and that a natural system where insects, diseases and fire play a natural role is the right way to manage. A logger might see the same piece of land as employment and income opportunity. A pathologist might see the land as needing to be harvested in order to reduce the potential for disease and thereby improving the health of the stand. While we all know this and understand the differences in people's desires we don't seem to be very tolerant of them.

The ongoing controversy over the fires in Yellowstone Park is a great example of different values at work. While some people are pleased that fire took a role in cleansing the Park, others feel that the overmature lodgepole pine should have been logged in order to keep the catastrophe from happening. Some people say what do you expect when you have a mountain pine beetle epidemic and others say it is the natural way of things and as it should be. Which group is right?

Pathologists need to help land managers understand the consequences and tradeoffs of the many "right" ways of managing the public's land. They need to work harder to understand public desires and to help discover methods of meeting those desires. Of course, public education plays an important role, but public education doesn't mean asserting your values onto them. It means helping them to find ways of meeting their desired future condition and helping them understand the consequences of various options for management.

I believe pathologists have contributed significantly to the future of public lands and I believe you will continue to do so. But I think the challenge of understanding and incorporating the social aspects of public land management has not yet been met. I hope you are up to the challenge.

IN MEMORIAM - CLARENCE R. QUICK

Clarence R. Quick passed away at the age of 85 in a Sacramento nursing home. A native of Nebraska, he and his family moved to California in the early 1900's and settled in Fresno County. He graduated from the college of the Pacific and the University of California, Berkeley, and spend 37 years doing forestry research in Berkeley as an ecologist and plant pathologist. in the Bureau of Plant Industry and the Pacific Southwest Forest Experiment Station. Here he wrote numerous articles on forest tree diseases, native seed germination and other forest ecology problems, including several contributions to WIFDWC meetings at which he was an active participant.

He was an honorary member of the California Academy of Sciences in San Francisco and collected plant specimens in California for its herbarium. He was also active in the California Botanical Society and the Native Plant Society. Shortly after his retirement in 1967 he moved to Merritt Island near Clarksburg.

Clarence is survived by his wife, Alice Pylman Quick of Merritt Island; son Roger of Corvallis, Ore.; and sister Velma Berry of Fresno.

DIVERSE PERSPECTIVES ON DISEASES AND PATHOLOGISTS

VIEWS FROM A WILDLIFE ECOLOGIST

Winifred B. Sidle

The traditional lack of cooperative work between forest pathologists and wildlife biologists suggests that the two disciplines have few interests in common. In reality, there is great potential and need to cooperate in developing programs of research and management. Forest pathogens, as well as management efforts to prevent or control diseases, affect the structure, composition, and vigor of forest stands. Forest stand structure, composition, and vigor control important attributes of wildlife habitat including: 1) thermal cover effectiveness; 2) security cover effectiveness; 3) habitat structural diversity; 4) special habitat components, such as dead or diseased trees; 5) production of understory forage; and 6) production of soft and hard mast. A case example is provided of why forest pathologists and wildlife biologists must increase their level of cooperation in planning research programs and in developing management strategies for forest stands.

WINIFRED B. SIDLE is a wildlife ecologist and associate research professor, Department of Forest Resources, Utah State University, Logan, Utah.

HOW ECONOMICS CAN CONTRIBUTE TO THE
APPLICABILITY OF FOREST PATHOLOGY RESEARCH

Steven E. Daniels

ABSTRACT: An informal survey of foresters shows that forest pathology is not generally viewed as central to the future of forestry. Forest pathologists therefore find themselves in a situation similar to that of forest economists, since neither group has been particularly well received. Techniques in marketing and intergroup communication have been recognized by some forest economists as offering some improvement. These techniques are presented with the assumption that forest pathologists may also find them helpful.

INTRODUCTION

There are any number of levels at which economics can contribute to the study of forest pathology. The most obvious of these are the various technical issues where economics applies: the various rules for maximizing research returns, optimal treatment levels of forest diseases, and optimal rotation length given possibility of catastrophic volume losses. All of these are ways in which management and research of disease pests can be facilitated by the application of economic rationale.

There is another aspect of economics that has perhaps more relevance, however, and that is its social science component. Much of what has been said at this meeting, combined with the sessions explicitly devoted to the topic, make it clear that your organization is concerned about its place in forestry. You are questioning your development as a specialty, your self-perception, and the perception of others of your profession. It is to this topic that I plan to direct my comments and hope to make some contribution.

THE PROBLEM

In preparing for this panel, I felt it was important to get the impressions other forestry professionals have of forest pathologists since my own experiences are limited. Quite frankly, the results of my informal survey were bleak. The bulk of the comments indicated that others perceive you as being rather insular and with a strong tendency to fail to contribute substantially to the overall progress of forestry. Debates about the validity of these perceptions should not distract you: it is their existence that should concern you, not their factual basis. It is others' perception of you, not your own, that will determine your place in the general forestry community.

An additional result from my survey that was particularly striking was the similarity between forest economics and pathology, at least in the way the two specialties are viewed by more general foresters. Neither specialty can be described as well liked,

STEVEN E. DANIELS is an assistant professor of forest economics and policy, Department of Forest Resources, Utah State University, Logan, Utah.

and a number of factors may explain this. First, both economists and pathologists are often trained in departments other than forestry schools. This may make them less acceptable than someone with more "forestry" training. Second, both economists and pathologists tend to publish in journals other than strictly forestry publications. This may make their work less well known in forestry circles than it otherwise might be. Third, and perhaps most importantly, both disciplines tend to establish constraints to management. Rather than establish opportunities, both fields are "wet blankets" that eliminate rather than enhance managerial options. These factors combine to make both economists and pathologists virtual pariahs to more general foresters.

THE SOLUTION

Rather than just commiserate about the cold reception our specialties tend to receive, I would like to present five recommendations for improving if not the relevance of forest pathology, at least the perception of its relevance by others. Some of these are more applicable to academicians and some to agency personnel. My hope is that everyone will see a grain of truth in at least one of them.

Economists have recognized these aspects of their profession and have made preliminary steps to make their work more generally accepted. Since economists spend more time with both marketers and sociologists than forest pathologists typically do, my hypothesis is that some of the things economists have learned are both new and relevant to forest pathologists.

1. IDENTIFY RESEARCH PROJECTS THAT ARE BOTH RIGOROUS AND RELEVANT. The world is full of topics that are scientifically rigorous or policy relevant. The trick is to find projects that are both. I suspect that there are enough problems in the latter category to keep us all busy, but they are a little harder to find. Doing research on this set of topics insures that both your fellow scientists and managers will find your results interesting and useful.

2. THREE DIFFERENT TYPES OF PUBLICATIONS SHOULD COME FROM EVERY PROJECT: RIGOROUS SCIENTIFIC, POPULAR SCIENTIFIC, AND POPULAR. The ability to generate these different types of results is a good test of meeting suggestion. #1. Moreover, this is a valuable exercise in market differentiation since no single publication reaches all audiences or communicates all ideas. Finally, no research project should be considered completed until all of these publications have been prepared.

3. AVOID JARGON. When explaining results to others, avoid professional shorthand wherever possible. The classic acronym, KISS (Keep It Simple, Stupid), should be a constant reference. Economists are notoriously bad at saying simple ideas using complicated terms. The tendency to use jargon is understandable--if your discipline has a special language, it provides a degree of job security since nobody from another discipline knows the language. Nevertheless, the jargon has the undesirable side effect of making your work less accessible and therefore less relevant to others.

4. AVOID PROFESSIONAL BIAS OR PECKING ORDERS. Economists have a particularly strong professional bias: more mathematics equates to better economics. Our pecking order is a direct offspring of this bias: the best economists are indistinguishable from applied mathematicians. The result is a strong tendency to choose highly mathematical approaches to problems even though the basic results might be obtained with more elementary techniques. This pecking order also makes it difficult to publish any results except for the most mathematical.

While I have little data to support this hypothesis, I suspect that forest pathologists have a similar pecking order. Yours probably differs from the economists' in that it is based on biology or chemistry, rather than mathematics. If a similar pecking order exists, it acts to reduce the general policy relevance of your research. Recognizing both the existence and effects of your professional pecking order would be a first step in outgrowing it.

5. UNDER-PROMISE AND OVER-DELIVER. This concept comes from recent work in corporate strategy and may be easily explained in terms of two automobile mechanics and the service each promises to provide. Table 1 shows both their promises and their performance.

Table 1--Hypothetical performance of two automobile mechanics

		Time Promised	Time Delivered
Mechanic	A	3:00	2:00
	B	12:00	1:00

Mechanic A made the modest promise to deliver the car by 3:00 and bettered that promise by an hour, while B was more optimistic but failed to meet his promise. A survey of most people would reveal that they rate A as superior, even though B actually delivered the car an hour earlier. The key is that others' perceptions of our performance is not based on either promises or absolute performance, but on our performance relative to expectations established by our promises.

This point is directly relevant to both researchers and practitioners. If a researcher promises a solution to the dwarf mistletoe (*Arceuthobium* sp.) problem in two years, and it takes three, he may not get more funding. Never mind that the accomplishment in three years is a breakthrough. He failed to meet the expectations his promises established and therefore under delivered.

CONCLUSIONS

Nothing I have said today is earth shattering, but hopefully it has been helpful. I thought it presumptuous to try to tell you what is technically wrong with your field, but it might interest you to learn some strategies to improve the communication of your research results. The idealists among you may find it demeaning to think about "packaging" research to make it more attractive to others. This attitude will result in your work being peripheral to the overall future of forestry, when in fact it could be much more.

INCORPORATING PEST MANAGEMENT INTO
LAND MANAGEMENT DECISIONS

Borys M. Tkacz

The preceding speakers have given us pathologists a series of challenges with the aim of incorporating disease management into land management programs. We have been asked to do more than just provide assessments of pest conditions in special reports; to avoid "depressing" foresters by preaching "doom and gloom"; to leave a part of ourselves on the District; and to work as part of the resource management team. In response to these challenges, I will present how Forest Pest Management (FPM) in the Southwestern Region is working toward incorporating pest management into land management decisions.

The USDA Forest Service has recently completed a report titled: "Forest Health Through Silviculture and Integrated Pest Management: A Strategic Plan" (USDA Forest Service. 1988a). The objective of this plan is to "enhance and maintain the health of the nation's forests . . . through Forest Service programs and authorities." Forest health is defined as "a condition where biotic and abiotic influences on the forest (i.e., insects, diseases, atmospheric deposition, silvicultural treatments, harvesting practices) do not threaten management objectives for a given forest unit now or in the future." One of the recommendations in this report was to "require pest specialist input to National Forest System interdisciplinary teams conducting forest resource management planning." The rationale for this recommendation was that Forest Plans mention but do not provide for practicing pest management and that priorities for forest management activities rarely consider forest pest impacts.

Forest health is a desired future condition. In a recent message to silviculturists in the Southwestern Region, the group leader for silviculture stated that: "There is nothing more important that silviculturists can do than to pass on to the next shift of silviculturists and forest managers a resource that is in a healthier condition than the one they inherited." Although most Forest Plans gave us specific management objectives by area, they did not present a very clear picture of the desired forest conditions to meet them. Clear descriptions of desired future conditions for specific sites will be needed for implementation of Forest Plans.

Implementation of Forest Plans in the Southwestern Region is following the Integrated Resource Management (IRM) philosophy which recognizes the intricate interrelationships between all the natural resources (USDA Forest Service. 1988b). An interdisciplinary (ID) approach is being utilized to design impact generating projects. Attempts are made to identify the resources involved, define the resource interrelationships, and to reasonably predict the effects or impacts of projects. Project design and implementation follows a 13-step process that closely parallels the NEPA (National Environmental Policy Act of 1969) process:

PHASE 1 - REVIEW FOREST PLAN - Determine if proposed project is necessary and how it contributes to the accomplishment of Forest Plan goals and objectives.

BORYS M. TKACZ is the Forest Pest Management Plant Pathologist for the USDA Forest Service, Flagstaff, Arizona

PHASE 2 - DEVELOP PROJECT CONCEPT - Determine precisely what this project will be designed to do and why.

PHASE 3 - CONDUCT EXTENSIVE RECONNAISSANCE - Visit project area to determine whether the project concept will work.

PHASE 4 - PREPARE FEASIBILITY REPORT - Prepare scoping report demonstrating the proposed project's technical, economic, and public feasibility.

PHASE 5 - UPDATE FOREST PLAN 10-YEAR IMPLEMENTATION SCHEDULE - Amend schedule as necessary.

PHASE 6 - CONDUCT INTENSIVE RECONNAISSANCE, SURVEY, OR DESIGN - Collect information to design a project that addresses the issues, concerns, and objectives.

PHASE 7 - GENERATE AND COMPARE ALTERNATIVES - ID Team develops and compares a reasonable range of alternatives.

PHASE 8 - SELECT ALTERNATIVE - Line Officer selects alternative to be implemented and determines what NEPA documentation is appropriate.

PHASE 9 - PREPARE NEPA DOCUMENTATION - Complete environmental documentation, notify public of the decision, and resolve any conflicts.

PHASE 10 - CREATE PROJECT RECORD - All pertinent information is in a single packet at one location for easy access.

PHASE 11 - PREPARE PROJECT ACTION PLAN - Produce a work schedule specifying who does what, when, where, and how.

PHASE 12 - IMPLEMENT PROJECT - Complete project in accord with the final decision.

PHASE 13 - MONITOR AND EVALUATE RESULTS - To determine success or failure of project design.

Forest Pest Management specialists in the Southwestern Region are involved in the initial scoping phases of the IRM process by identifying the issues, concerns, and opportunities related to insects and diseases that may affect project objectives. Where needed, biological evaluations are conducted to investigate the ecology of pest-host systems and to determine the impacts of unregulated pest populations on resource values. If pest situations have the potential to significantly affect project objectives, then FPM specialists are involved in the alternative generation and comparison phase of IRM by becoming members of the ID Team. FPM specialists assist in selection of stands to be treated by incorporating pest management needs into silvicultural treatment priorities. The ID Team may develop specific alternatives to deal with pest situations. Evaluation criteria for comparison of alternatives may include some measure of pest suppression or prevention such as acres treated for dwarf mistletoe or acres with reduced bark beetle hazard. After alternative selection, pest management information is incorporated into appropriate NEPA documentation.

During the preparation of project action plans, FPM specialists provide assistance in project layout and development of contract provisions. Unexpected circumstances during project implementation may require modification of the action plan. Once the

project is completed, FPM specialists assist in monitoring project effectiveness. Post treatment evaluations are conducted to determine if project objectives were met.

In the Southwestern Region, we are trying to incorporate pest management considerations into project plans through the IRM process. By being involved in all phases of IRM, from the initial development of project concepts to the eventual implementation and monitoring of success, we are insuring that pest effects are considered in land management decisions. Hopefully, this will help us leave a healthier forest than we inherited.

LITERATURE CITED

- USDA Forest Service. 1988a. Forest Health Through Silviculture and Integrated Pest Management - A Strategic Plan. Edited by Tim McIntire. USDA Forest Service. Washington, D.C., 26p.
- USDA Forest Service. 1988b. Project Implementation Process for Integrated Resource Management (2nd Edition). USDA Forest Service, Southwestern Region, Albuquerque, New Mexico, 36p.

DIVERSE PERSPECTIVES ON DISEASES AND PATHOLOGISTS

John Schwandt, Moderator

INTRODUCTION

This panel included scientists and practitioners from a wide variety of fields other than forest pathology. Participants included:

Jack Admundson, Forest Silviculturist, Targhee National Forest, St. Anthony, Idaho
Winifred Sidle, Wildlife Ecologist and Associate Research Professor, Utah State University, Logan, Utah
Ollie Jones, Recreation Forester, Salt Lake City Ranger District, Wasatch National Forest, Salt Lake City, Utah
Steve Daniels, Assistant Professor of Forest Economics and Policy, Utah State University, Logan, Utah
Clyde Thompson, Evanston District Forester, Wasatch National Forest, Evanston, Wyoming
Richard Klason, Utah State Forester, Utah Division of State Lands and Forestry, Salt Lake City, Utah
Boris Tkacz, Plant Pathologist, Forest Pest Management, Southwest Region, Flagstaff, Arizona

Information and perspectives presented were very interesting, thought provoking, and even humorous (you had to be there). Unfortunately most speakers declined the invitation to see their perspectives in print, so I have tried to summarize a few of their more salient comments. This will be followed by notes from the speakers who did wish to have their discussions included in our proceedings.

PANEL SUMMARY

The idea of the panel was to get some firsthand feedback from a variety of people regarding their relationships towards forest pathology and pathologists. We pathologists have often been accused of talking to ourselves, so someone suggested we contact people in other natural resource areas to obtain some "diverse perspectives on diseases and pathologists."

Jack Admundson led off by explaining how we may "be telling the story," but are not getting the point across. He noted that wildlife seems to be getting "good press," and that we need to find an avenue to achieve something similar.

Winifred Sidle prefaced her remarks by explaining that her perspective might be affected by 10 years of fraternizing with the likes of Jim Hoffman and Boris Tkacz. She went on to emphasize that we need better teamwork between other related fields. She explained that when she looked at a stand of timber, she automatically watched for characteristics affecting wildlife. She could look right past trees with heavy dwarf

JOHN W. SCHWANDT is the Idaho State Forest Pathologist for the Idaho Department of Lands, Coeur d'Alene, Idaho.

mistletoe infections while pathologists would readily see the mistletoe, but not be aware of the wildlife characteristics. A recent trip conducted jointly with a pathologist turned out to be a very eye-opening experience for everyone. She strongly felt that this type of cooperation/coordination should be encouraged at all levels. Another point was made that an Outdoor Recreation Symposium was being held nearby, and neither group was aware of (or had been invited to) the others meeting.

Ollie Jones reflected the perspective that pathologists are the "Gloom and Doom" folks and that we need to come up with a more positive approach. Diseases may cause problems, but maybe we should look at them as providing new challenges and new opportunities for creative timber management. She felt that it was important that we should get to know the recreation managers, silviculturists, and others involved in local resource management so that they know who we are. She emphasized the need to get in on the early planning stages by providing disease evaluations and "risk assessments."

Steve Daniels reported that we have many things in common with economists which are not necessarily good. He explained that neither one of our professions give very cheerful perspectives. He also passed on some points for improvement that economists have been working on; including the need to communicate more effectively and in a broader scope, avoid jargon (host/pathogen = victim/attacker?), and especially urged us to "under promise" and "over deliver" to improve our image. He also suggested that research needs to be both rigorous and relevant. (A more complete text follows.)

Clyde Thompson explained that many foresters and professionals in related fields need more training in pathology. He also suggested we try to provide more site-specific recommendations instead of broad generalizations which may be of little value to a practitioner.

Richard Klason sees the need for a broader base to our efforts with some additional emphasis on urban forestry. The state of Utah is currently considering hiring an urban forestry specialist with pest management experience rather than a pathologist with an urban forestry background.

Boris Tkacz explained how the Southwestern Region is attempting to meet the challenges brought up by several of the speakers (see complete text). He feels that much can be accomplished through the "Forest Health Initiative" recently developed by the US Forest Service.

CONCLUSION

Many of the observations and suggestions made by these panel members were reiterated throughout the rest of the conference and were especially relevant to the panel on forest health. Improving the image of pest specialists is also a topic for discussion for the combined pathology/entomology meeting next year at Bend, Oregon. I hope that you will give this topic some thought in the meantime, and come to next year's meeting prepared with some specific recommendations.

HAZARD TREE/VEGETATION MANAGEMENT PANEL UPDATE

James T. Hoffman, Moderator *

Concern for public safety has always been the foremost objective of recreation managers in developed recreation sites. However, it wasn't until the early 1960's that the formal foundations of hazard tree management were developed by research plant pathologists in California. Undoubtedly because of the professional tie, plant pathologists working for the various governmental land management agencies became responsible for most technology transfer aspects of hazard tree programs.

During the last 25 years, recreation managers have dealt with an explosion of recreation site use. Fortunately awareness also increased that action was needed to not only deal with hazard tree situations, but to sustain, or in most cases, replace campground vegetation. Thus evolved the concept of vegetation management for recreation areas.

Simply defined, vegetation management is the manipulation and cultivation of natural or planted vegetation to achieve a safe, visually pleasing landscape. A vegetation management plan marries site-specific objectives for an area with knowledge of plant requirements for soil, light, moisture, space, and tolerance to pests, wind, and mechanical injury. In essence, a vegetation management plan is merely a silvicultural prescription written for a recreation site.

The panel members I've selected will talk about hazard tree and vegetation management programs from several perspectives.

John Muir is a plant pathologist with the Protection Branch of the British Columbia Ministry of Forests, Victoria, British Columbia, Canada. John will tell us about the hazard tree management program in British Columbia.

Bob Glenn, Recreation Staff Officer for the USDA Forest Service, Intermountain Region, Ogden, Utah will provide an administrator's view of plant pathologist involvement in recreation management.

For a local view, Ken Britton, Recreation Forester for the USDA Forest Service will illustrate examples of vegetation management techniques in the beautifully scenic Sawtooth National Recreation Area in central Idaho.

Finally, Ken Russell, plant pathologist for the State of Washington, Department of Natural Resources, Olympia, Washington will discuss the role of pathologists in the urban forest.

* Plant pathologist, USDA Forest Service, Forest Pest Management, Boise, Idaho.

The Role of Forest Pathologists in the Urban Forest

Kenelm W. Russell¹

Abstract: Growing public interest in trees and tree health taxes urban tree specialists' resources. Tips are provided on helping clientele through call-ins, timing and preparing media material for release, and enlisting other specialists for help. Suggestions are given for tree care and protection during development planning and construction. Tree pruning, shaping, and topping techniques are described and include a drawing of proper branch pruning.

Introduction

Trees have been part of mankind's intimate environment since the first clans and settlements, a relationship which continues into the modern urban environments of today. Looking back over history, there were many who paid official attention to and cared for the trees within the urban surroundings. William Penn, Thomas Jefferson, and George Washington are just a few of the early U. S. visionaries who saw the great value in using trees to enhance their environment.

Healthy trees form a vital part of our everyday existence; we tend to take them for granted not realizing the full impact of their softening and calming influence on harsh, artificial surroundings. There may have been a time in our recent past, probably during the industrial revolution, when trees in urban areas did not fare as well.

The Urban Forestry Explosion

In recent years, perhaps beginning with Earth Day in April, 1970, concern over our environment and general quality of life, and especially our trees became more important. People finally began realizing that our planet was in critical need of better care. In the late 1980's the noise about having healthy trees in our surroundings has risen to a loud clamor. Just a few years ago, trees were often an after thought in large building and shopping mall plans. Today, trees are a required part of the plot plan.

There are tree awareness groups springing up all over and they are true friends of trees. "Children of the Green Earth" in Olympia has diverse goals; one is devoted to afforesting parts of treeless India and another is dedicated to preventing urban sprawl

¹K. W. Russell is the Manager/Forest Pathologist of the Forest Pest Program for the Washington State Department of Natural Resources, MQ-11. Olympia, Washington 98504. Presented at the 36th Western International Forest Disease Work Conference. Park City, Utah. September, 19-23, 1988.

and wanton destruction of stands of trees that might be in the way. "Plant Amnesty," a Seattle group's goal is to "end the senseless torture and mutilation of trees and shrubs caused by malpruning."

Tree Problems in the Urban Setting

Urban trees suffer more diverse problems than their wild cousins. These include diseases, insects, and wounds resulting in decay and structural weakness (hazard trees), and a variety of adverse environment factors ranging from bad weather, air and water pollution, salt damage, kids with sharp objects, inexperienced adults with pruning tools, and errant car bumpers. In 1986 I saw large, although somewhat scarred trees in Hiroshima that survived directly beneath ground zero of the 1945 atomic bomb blast. That impressed me! Despite abuse and pestilence, trees have an amazing ability to survive.

Hazard Trees-an Awareness

In the 1960's forest pathologists and others became more aware (officially) of defective trees as potential hazards to people and property. The term "hazard tree" became known among professionals but the general public had to be educated. In the West, Willis Wagener's (1963) hazard tree guide for professional foresters was the first of several. At the WIFDWC in Estes Park, Colorado we heard about the legal implications of damages from hazard trees (Menefee 1973). California's own Yosemite Park had some serious accidents where people were killed from failing trees due to annosus root disease. This all came about because managers of Yosemite withheld natural fire from the valley and an overstocked pine forest that eventually became infested with annosus root disease grew up in place of the open savannah seen by the first explorers to the valley (MacGregor 1973). Pathologists and urban tree managers had to do some educating about the agents that could cause trees to become hazardous.

Reaching the Clients

Perhaps, many of you have experienced lengthy question periods following tree problem presentations to urban dwellers. The questions cover every aspect of trees; everyone wants to know more.

How do we expand our message? Foresters and land managers can be corralled at meetings and seminars. Urbanites with tree questions are everywhere. One professional can expand manifold by giving talks and conducting field trips for garden clubs, mushroom clubs, and a myriad of outdoor groups, but much more exposure is needed. The media is one of the best ways to get the word out. One person in an organization cannot do many house calls, even though occasionally necessary. If you run a one person show you have to use every trick in the book to improve outreach.

Call-in diagnosis. When the phone rings, I try to provide answers right now. I ask callers a number of questions, then give them the responsibility for sampling and diagnosis. I train them over the phone to accurately describe what they are seeing, because if they get it right, I am saved a trip. Sometimes we have to get pretty basic like, "Does it have broad leaves or does it have needles?" Eventually, I get a picture of the problem and I mail (next day service) illustrated literature that fits or "brackets" the problem. I may describe how to properly collect a sample to mail to the lab so I can confirm the diagnosis. A business card is attached to the mailing and callers are advised to call back if they have trouble.

Timing your information. Good timing of tree problem information release is one of the best ways to educate a large number of people with least effort. Capitalize on an event such as a bad storm, an insect or disease epidemic, or a damaging cold snap when everyone sees the damage and interest in trees is high. Trees are appreciated, but generally ignored, until something threatens their existence. Don't wait past the peak of "brown foliage." Anticipate, and have your material ready. Release information when you get a few phone calls about a problem or receive a handful of letters. This is how legislators sense a public mood. Such activity guarantees high interest in the material you prepare.

Written material. When there is a problem such as a regional hard freeze that causes widespread damage, I often prepare a written description of symptoms and a solution, if available, in the form of an open letter on original department letterhead. I may also write the description as a news release. This format does double duty because it can be sent both to callers and the news media without modification.

One release I prepared about the 1987-88 Pacific Northwest drought-caused tree damage was published in 18 statewide papers, some obscure, but serving a local public. I wrote the document in such a way that editors could print parts of it that stood alone, but most published it word for word.

When doing written material, here are a couple of very simple rules. Write for an eighth grade audience (reading level for the average bear). My formula is to try for a 13 word average sentence length. Usually, the final count is more like 17 words which is still ok. Keep paragraphs shorter than about 13 lines (Russell 1978). Use the ragged edge double column format when possible. Try your stuff on someone who doesn't know anything about it. If it's good they will let you know.

Sometimes it is helpful to produce a family of written material designed for different audiences. For example, our hazard tree information package comes in four different formats. A six panel, fold-out color brochure explains detection and correction of hazard trees to homeowners and the general public. The 37 page "textbook" explains hazard trees in depth and is targeted for foresters and managers of recreation areas (Mills and Russell 1981). A second book, printed on waterproof paper is for field use, without detailed explanation. It is the "how to" for the technician or person doing the evaluation. Lastly, we made a slide tape for all audiences; its major point being to show that trees can be hazardous and should receive careful periodic evaluation to ensure safety and good health.

Posters. Make posters, but leave out all the usual scientific stuff. This a far different kind of poster than you would make for a scientific meeting. Forget the scientific method, conclusions, etc; just tell what the subject is about or what to do about the problem. Make your poster sell like an ad for a new Honda or a dandruff controlling shampoo. Glue written material and pictures to foam board so they last. It's easy these days to make professional posters on the computer if you have a high quality printer and a selective font size and style. Leave white space, use bright, eye catching color, and keep the message simple. Make it an easy size to carry (30x40 inches-max).

Posters are perfect for county fairs, shopping mall programs, spring home and garden shows, and the numerous conferences you attend. They leave a quick message for people who care about or own trees. Leave pamphlets next to posters for a take home reference. Again, that incredible tool, the computer, makes it easy to produce beautiful material yourself; no hassles with complex printing processes.

Get on the evening news. Perhaps the best way to tell the greatest number of people about a tree problem is on the evening news. Let the subject matter do the selling, especially if the tree problem is widespread and very noticeable. This is where the sense of good timing for information release comes in. We expanded the newspaper drought coverage described above to TV by asking a Seattle station if they would like to do a news clip on tree damage. They were eager and showed up the next day. We capitalized on the fact that drought had been in the regional news nearly every evening. Emphasis had been on low reservoirs, dry crops, and shrinking creeks filled with spawning salmon. The brown trees were a shoo-in. The audience is about 250,000 in a metropolitan area like Seattle with six TV stations.

To explain how drought affects trees, we used the Sholander pressure bomb to show how the sun exerts tremendous internal negative pressures on tree water columns as moisture is vaporized through leaves and needles. The camera zoomed in on the pressure guage showing a reading of several hundred pounds. The TV crew liked the high tech equipment better than me just standing there talking. I then explained, "When the normally unbroken water column from root tip to tiny openings in the leaves is severed by the tremendous internal water tension, it cannot rejoin and parts above the break die. This is why you see trees with green bottoms and red tops." We finished with a discussion on what homeowners could do to reduce the stress (mulch, deep water, etc.).

Afterwards, I heard comments like, "That was really interesting. I didn't know trees could build that much water tension. I really learned something. In the next drought I'll take better care of my trees."

In another instance we were able to use the story about a large eagle perch designated Douglas-fir that toppled off a high cliff after heavy rains and flattened a \$150,000 Puget Sound beach house. The owner's wife and dog were nearly killed. The story became more intriguing when it was found that the homeowner had been trying for more than two years to get the county to cut the tree because he thought it might fall. Wildlifers would not allow it and the tree stayed. The attempt to cut the tree also made the evening news two years earlier and was pieced into the current affair. The headline was, "Do eagles take precedence over human life?" We used the incident to

talk about what makes trees dangerous. Viewers must have been shaken after seeing what a falling seven-foot diameter, 150-foot tall tree does to a house because many phoned in for our hazard tree brochure.

Colored pictures are nice but "tree talks" on the radio can also be very effective. We used radio to explain what was happening with wild edible mushroom legislation. Conversations were regular and over a month developed into quite a story. People were well informed.

Enlisting the aid of consultants. These days consultants are everywhere. They are the ones who might be at seminars where you are speaking. Give them your written material and train them in tree problem diagnosis. I have received a definite boost from these folks in the last few years. Another helpful group, the pest control operators, also have constant contact with the public: Most states require licenses and you may have opportunity to address pest control operators annually when they return for mandatory recertification training. You can be involved in designing annual training as well. I have only just begun to realize the value of these people in helping the public learn about tree problems. It sinks in when you realize you and your peers could conceivably talk to more than a thousand operators in two or three annual sessions.

Tree Planning in New Development

Few developers, architects, and homebuilders understand the importance of careful positioning of buildings around existing trees and the need to protect them properly during construction. It is always sad to visit a new home on land carved out of the forest by a developer and have to advise the young and somewhat inexperienced owners that their tree eight inches from the foundation may damage the house, or that the nice back yard maple is nearly dead because it has three feet of heavy clay backfill around it. A knowledgeable developer with a pre-construction tree plan and a few tree damage penalty clauses in building contracts can avoid most of these problems. Try to get on their association speaker rosters to talk about tree care planning before development.

At a college in Western Washington the first of a two-phase student apartment project was completed. The college was built on 1100 acres of forested land in the early 1970's. After the original buildings were completed, a strict tree removal policy was established forcing architects to fit new buildings into the trees. Often, the fit was too close. Many large trees became very dangerous a few years later from the construction damage and release shock. The situation was not safe, especially around wood frame student housing.

I was called to help with the problem after the buildings were completed and had to recommend the removal of several trees which were extremely dangerous. I was appalled at the damage the trees had sustained during construction. Some had nearly all of the roots severed and others were nearly girdled by equipment. We started right in with a hands-on session on safe tree location around buildings and their protection during construction.

The buildings and grounds people were pleased to learn more about the safety and care of trees as we worked together to remedy the situation. What amazed me through this process was the fact that as an environmentally sensitive institution, little attention was paid to a tree care plan during construction.

The story was dramatically different when phase two was built. This time, buildings were placed appropriate distances from residual trees. Trees too close to building sites were removed. Barriers were built to protect trees from construction injury. The difference was remarkable, and there was little tree care follow-up cost.

Pruning, Shaping and Topping

The discussion in this section summarizes my demonstration on pruning, shaping, and topping conifers. The objective was to show how to make a tree smaller, safer, yet aesthetically pleasing.

Tree pruning is a time honored art that has evolved since trees became useful to civilization. Recent research has shown that tree pruning techniques could be improved (Shigo 1986), (Shigo, Vollbrecht, and Hvas 1987). While some may argue the scientific principles behind these new tree care concepts, they are nevertheless easy to understand for homeowners and tree care experts alike. Tree care companies, utility companies, recreation site managers, foresters, and others are using the new technology. The improvement in tree maintenance along roads and under power lines is noticeable.

Topping and shaping. This procedure is recommended for conifers when dead or broken tops need to be removed. Tall conifers near buildings or valuable property that catch too much wind can be made smaller by topping and shaping (tapering) the new crown into a natural appearance. To further reduce windage, it is often desirable to remove up to one third of the live branches throughout the crown. The resulting tree presents less area to the wind and will appear quite normal within two to five years.

Most pathologists agree that top decay around the cut in most conifers is low if the tree was topped at the smallest possible diameter (around four inches) (Ferrell and Scharpf 1982). It is a good idea to check topped trees about every 10 years to assure continued safety.

Topping hardwoods is not recommended. While conifers usually have only a central stem, hardwoods have many, and topping would leave many heavy side branches which ultimately become dangerous. Hardwoods are much more decay prone than conifers. Wounds from severe topping traps moisture, encouraging decay and dieback. Hardwoods must be carefully pruned and thinned of only smaller or medium branches to promote rapid branch scar sealing and a natural and pleasing shape.

Pruning techniques. For hundreds of years people have been taught to prune flush with the trunk. Now, the recommended practice is to make the cut just outside the branch bark ridge at the base of the branch without injuring the ridge or the branch collar (Figure 1).

The branch bark ridge is the wrinkled bark line that forms where branches join the trunk. On conifers, it encircles the branch (collar like) while on hardwoods, it drapes over and down the sides of the branch junction like a droopy mustache. Cutting between the main trunk and the ridge or into the ridge itself, partially destroys the ability of the wound to seal over rapidly and decay will result. Branch whorl swellings on small diameter conifers nearly touch each other around the bole. Take special care not to girdle the trunk when removing a complete branch whorl. Keeping outside the branch bark ridge and the branch collar tends to prevent this from happening.

Consider branch size when pruning. Pruning large branches takes years for the wound to seal. To promote lifelong tree health and safety, plan regular and early pruning when trees are young and branch diameter is small. This reduces the cut surface area and decay potential.

Area of exposed surface can be dramatically different when comparing proper and improper pruning. It is possible to make a four-inch diameter flush cut next to the trunk when a two-inch diameter cut would result if it was made outside the branch bark ridge and collar. The area of the large cut is 12.56 square inches and the area of the small cut is 3.14 square inches. The small cut may seal over in five to seven years while the larger one could easily take twice or three times as long to seal. Decay could enter the wound during the long period of exposure.

When dead branches are pruned, it is essential that the live callus around the branch not be injured. Cutting into the callus only enlarges the cut surface and allows additional decay to enter the tree.

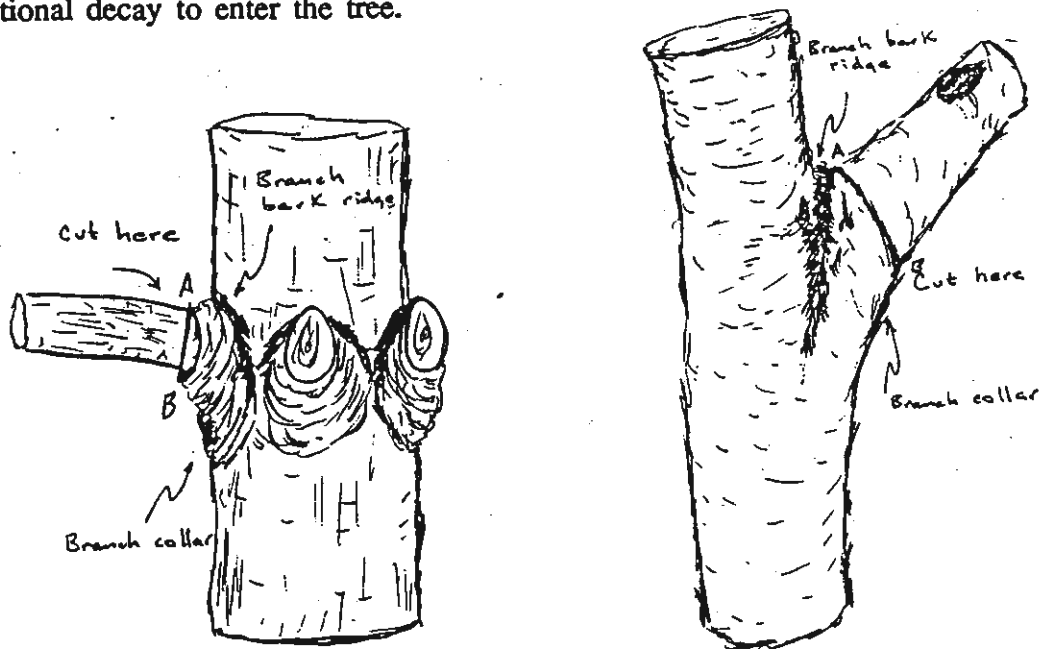


Figure 1--Proper way to prune branches on conifers (left) and hardwoods (right). Prevent additional tree injury when the branches are large enough to tear the bark, or when using a chainsaw by first cutting the branch a foot or more from the trunk. Then make cuts from B to A. Do not cut inside the branch bark ridge in the crotch or leave a long stub (Shigo et al 1987).

REFERENCES

- Ferrell, G. T. and R. F. Scharpf. 1982. Stem volume losses in grand firs topkilled by western spruce budworm in Idaho. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. Research Paper PSW-164.
- Menefee, C. 1973. The legal implications of hazards from tree disease and related factors in recreational areas. In 21st Proceedings: Western International Forest disease Work Conference. Estes Park, Colorado.
- McGregor, N. J. 1973. Fomes annosus in forest recreation sites: management implications. In 21st Proceedings: Western International Forest Disease Work Conference. Estes Park, Colorado.
- Mills, L. J. and K. W. Russell. 1981. Detection and correction of hazard trees in Washington's recreation areas. DNR Report No. 42. Washington State Department of Natural Resources, Olympia, WA 98504.
- Russell, K. W. 1978. Improving extension and training programs for dwarf mistletoe control. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. General Technical Rept. PSW-31.
- Shigo, A. L. 1986. A new tree biology: facts, photos, and philosophies on trees and their problems and proper care. Shigo and Trees Associates, 4 Denbow Road, Durham, NH 03824.
- Shigo, A. L., K. Vollbrecht, and N. Hvass. 1987. Tree biology and tree care: photo guide. Shigo and Trees Associates, 4 Denbow Road, Durham, NH 03824.
- Wagener, W. W. 1963. Judging hazard from native trees in California recreational areas: a guide for professional foresters. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. Research Paper PSW-P1.

HAZARD TREE MANAGEMENT IN BRITISH COLUMBIA

J. Muir and K. Joy¹

ABSTRACT

In British Columbia, government agencies and tree maintenance service consultants undertake inspections for tree hazards and stability, and remove hazardous trees where necessary near buildings or other facilities that are frequently used by the public. Technical information and advice are provided by the Canadian Forestry Service and B.C. Forest Service. Provincial Parks undertakes a systematic inspection of trees in or near high-use areas, whereas other agencies generally deal only with specific trees that are noted by staff or public.

INTRODUCTION

Programs to assess and if necessary deal with hazardous trees have been implemented by several government agencies in British Columbia (B.C.) that have jurisdiction or management responsibilities for land, including federal, provincial and municipal governments. The following overview of hazard tree management programs in B.C. is based on a limited review, and interviews with a few agencies.

GOALS

All agencies are concerned with providing a safe, aesthetically pleasant, treed or forested environment for visitors and residents. Safety considerations are paramount, and most agencies will take steps to protect visitors or residents by removing hazardous trees or restricting public access. Potentially hazardous trees are reported either by agency staff or by public visitors. Where the hazards or potential removal of hazardous trees is contentious or controversial, most agencies solicit technical or professional advice from the Canadian Forestry Service, B.C. Forest Service, or a tree maintenance service.

PROVINCIAL PARKS

A detailed and extensive tree inspection program is undertaken by B.C. Provincial Parks.

1. Forest Pathologist, B.C. Ministry of Forests, Protection Branch, and Forest Resource Officer, B.C. Ministry of Parks, Victoria, B.C., Canada. Presented at 36th Western International Forest Disease Work Conference, Park City, Utah, U.S.A., September, 1988.

Most high-use areas campsites, picnic areas, and intensively used roads and trails in our 385 parks are examined by park staff each year for forest tree diseases. They are minimally trained to recognize tree diseases by using external indicators, fruiting bodies, thinning or reduced foliage, adjacent damaged trees and a detailed guide to common diseases.

Forest Insect and Disease Survey (F.I.D.S.) of the Canadian Forest Service (C.F.S.) through their ranger program provides an identification service for forest tree diseases in our 221 high use parks. Their survey results are tabulated and rated in order of severity of concern. A high level of concern on their rating scale is (3); a low rating is (1). This rating helps our park managers to determine the level of action to be taken. In many instances a follow-up survey is the next step in an attempt to quantify the problem. Survey expertise may be supplied by C.F.S., B.C. Forest Service, or by private contractor. Following the mapping of each tree, a budget is estimated and contracts for tree removal are let. In situations where very few trees are involved park staff may undertake the tree removal process.

This procedure is accomplished within a decentralized agency system which, to work effectively, requires regular inputs of staff training and updating on new techniques for identification and for tree removal practicalities.

Our 1988/89 program will include the development of a video-tape training module using the basic information and techniques developed in "Tree Hazards in Recreation Sites in British Columbia Management Guidelines" (Wallis, et al. 1980). A summary of recent hazard reduction programs is shown in Table 1.

TABLE 1. TREE HAZARD CONTROL PROGRAMS,
1980 - 1987.

PARK	EST AREA (HA)	TREE SPECIES	PATHOGEN(S)	NO. OF TREES REMOVED
Goldstream	50	D. Fir, G. Fir, W. Hemlock	Phellinus, Fomes, Polyporus	1250
Lakelse Lake	30	W. Hemlock, Sitka Sp. W. Red Cedar	Fomes, Phellinus, Poria, Ganoderma	1200
Strathcona Park Campground	20	D. Fir, W. Hemlock	Phellinus, Fomes	240

Most other agencies do not have a systematic inspection program, but rely on reports from staff and public.

VEGETATION MANAGEMENT

Relatively few agencies have a program to actively manage vegetation in campsites, parks and urban areas. A few parks have undertaken prescribed burning to reduce fire hazard and maintain seral vegetation. Vancouver Parks Board has actively managed Stanley Park in downtown Vancouver, and over several decades, has converted the old-growth decadent, Douglas-fir - western red cedar forest to a younger, vigorous western hemlock, mixed-species forest. On the other hand, B.C. Parks has maintained an old-growth Douglas-fir forest at Cathedral Grove, near Port Alberni, with only a few trees removed near some of the facilities or along the highway. Visitors are warned not to enter the forest during winds.

PROGRESS

Although training of staff and limited budgets are chronic problems in most organizations, there have been some notable successes.

For example, at Goldstream Provincial Park, an extensive infestation of laminated root rot was discovered in 1979 when a tree collapsed near a campsite. This event resulted in the development of the B.C. Parks Tree Hazard Control Program (Wallis et al. 1980). Subsequently, at Goldstream trees have been inspected at least twice per year, in and near several large root rot infection centers, and trees with declining crowns have been removed where necessary. To date, these management actions have prevented any tree collapses in or near the visitor facilities.

OTHER PESTS

A final note to the tree hazard program is the removal of infested trees that threaten trees in other localities. B. C. Parks has, in cooperation with the B.C. Forest Service, taken active measures to eradicate mountain pine beetle and spruce beetle infestations in parks that threaten nearby forests. Although the need has not yet arisen, B.C. Parks policy also facilitates similar action against forest pathogens or diseases.

LITERATURE CITED

Wallis, G.W., D.J. Morrison and D.W. Ross. 1980. Tree hazards in recreation sites in British Columbia. Management Guidelines. B. C. Ministry of Environment and Parks, Can. For. Serv. joint rep. 13.

PANEL - MISTLETOE CONTROL WITH ETHEPHON

I. INTRODUCTION.

Frank G. Hawksworth and David W. Johnson, Co-coordinators.

A safe and effective chemical control for the dwarf mistletoes has been an elusive goal of western forest pathologists for many decades. One of the first projects undertaken by WIFDWC was a summary of the many tests that had been made up to 1955. Gill (1955) listed 260 tests that had been made by 7 investigators in the western United States and Canada. Nearly 60 different chemicals were tested, most were various formulations of 2,4-D or 2,4,5-T. None of the chemicals tested were effective in killing mistletoe plants without injuring the host tree. Also, none of the chemicals tested affected the mistletoe endophytic system within the host so re-sprouting occurred. Gill's report was followed by updates by Quick (1962) and Scharpf (1972). In general, the conclusions were the same as for the 1955 summary although Quick (1962) suggested that some formulations of 2,4,5-T showed promise as a practical control in high value trees. Quick (1964) gave results of the most intensive chemical tests for dwarf mistletoes involving over 2,500 trees in California and concluded that the isooctyl ester of 2,4,5-T was the most effective in killing mistletoe shoots with the least amount of host damage. In spite of its early promise, 2,4,5-T found little acceptance as an operational management tool for mistletoe control and is now, of course, banned for any forest use in many areas.

But, the search for the magic bullet to permanently control dwarf mistletoes without damaging the host continued, but at a lesser pace. The lone pioneer in this field for several years was Dr. Arthur Moinat, a retired plant physiology professor, who has continued his one-man battle against ponderosa pine dwarf mistletoe at Estes Park, Colorado, since about 1970. Moinat (1988) has tested many kinds of herbicides and growth regulators (Dacamine, MCPA, Butyrac, Goal, Thistrol, D-40, Weedone, Emulsamine, DPX, Prime, Florel, etc.) and although he gets good mistletoe shoot kill with most of these with minimal host damage, none of them affected the endophytic system and resprouting occurred. His tests using systemic chemicals that might affect the endophytic system are inconclusive to date.

Although ethephon has been under test by Dr. Moinat and also by Don Knutson for at least 15 years, active testing and development of the chemical has been only during the past 5 years or so. The success with ethephon on Eastern dwarf mistletoe (Arceuthobium pusillum) on black spruce (Brungardt 1985; Livingston and Brennan 1983a, 1983b; Livingston et al. 1985) sparked interest in trying ethephon in the dwarf mistletoe-rich West. Dr. Tom Nicholls of the USDA Forest Service North Central Station utilized a detail at the Rocky Mountain Station in 1982 to begin ethephon tests on lodgepole pine dwarf mistletoe (Arceuthobium americanum) in Colorado. His research showed that ground spraying of the chemical was very effective in causing dwarf mistletoe shoot abscission (Nicholls et al. 1987a, 1987b), although aerial sprays using helicopters were

FRANK G. HAWKSWORTH is forest pathologist with the USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. DAVID W. JOHNSON is forest pathologist with the USDA Forest Service, Rocky Mountain Region, Timber, Forest Pest, and Cooperative Forest Management, Lakewood, Colorado.

not effective (Robbins et al. 1989). The chemical was also found to cause shoot abscission in ponderosa pine dwarf mistletoe (Arceuthobium vaginatum) (Nicholls et al. 1987a, Johnson and Hawksworth 1988). Similarly, tests with the leafy mistletoes Viscum album on silver fir and hardwoods in France (Delabrazze and Lanier 1972) and Phoradendron macrophyllum (as P. tomentosum) on ash and walnut in California (Joyce et al. 1896, 1987; Han et al. 1988) showed that ethephon holds promise for shoot abscission with minimal host damage.

Research on ethephon on non-target organisms is rather limited but the results to date suggest little serious side effects (Nicholls et al. 1987a). However, a recent paper shows that leaf-eating rose beetles preferentially attacked ethephon treated plants (Arita et al. 1988), so caution should be exercised to watch for possible similar reactions to insects that attack conifer foliage.

With the increased interest in use of ethephon for various species of Arceuthobium and Phoradendron, it was decided that this panel summarizing the tests to date and hopes for the future was in order. Thus we have invited representatives of the Rhone-Poulenc Ag Company (the manufacturer of ethephon) and pathologists who have tested the chemical on mistletoes to discuss their findings.

LITERATURE CITED:

- Arita, L. H., S. C. Furutani, and J. J. Moniz. 1988. Preferential feeding by the Chinese rose beetle (Coleoptera: Scarabaeidae) on ethephon-treated plants. *Journal of Economic Entomology* 81:1373-1376.
- Brungardt, S. 1985. Researchers play Scrooge to a dangerous and stubborn mistletoe. *Minnesota Science* 4:11-13.
- Delabrazze, P., and L. Lanier. 1972. Contribution a la lutte chimique contre le gui (Viscum album L.). *European Journal of Forest Pathology* 2:95-103.
- Gill, L. S. 1955. Summary of chemicals tested for controlling Western species of dwarfmistletoes (Arceuthobium spp.). *Proceedings of the Third Western International Forest Disease Work Conference*, p. 18-25.
- Han, S., A. M. Berry, and M. S. Reid. 1988. New ways to control mistletoe. *Proceedings of the California Weed Conference*, p. 42-45.
- Johnson, D. W., and F. G. Hawksworth. 1988. Reduction of ponderosa pine dwarf mistletoe with the plant growth regulator ethephon. USDA Forest Service, Timber, Forest Pest and Cooperative Forestry Management, Rocky Mountain Region Technical Report R2-42. 10 pp.
- Joyce, D., K. Rein, M. Reid, and A. M. Berry. 1986. Use of ethephon for control of broad-leaved mistletoe in deciduous trees. *HortScience* 21:872 (Abstract)
- Joyce, D. C., K. Rein, A. M. Berry, and M. S. Reid. 1987. Control of broadleaf mistletoe (Phoradendron tomentosum) with dormant season ethephon sprays. *Acta Horticulturae* 201:141-144.

- Livingston, W. H., and M. L. Brenner. 1983a. Ethephon stimulates abscission of eastern dwarf mistletoe aerial shoots on black spruce. *Plant Disease* 67:909-910.
- Livingston, W. H., and M. L. Brenner. 1983b. Ethephon, a plant growth regulator, stimulates abscission of eastern dwarf mistletoe (Arceuthobium pusillum) aerial shoots on black spruce (Picea mariana). Proceedings of the 30th Western International Forest Disease Work Conference, p. 104-107.
- Livingston, W. H., R. A. Blanchette, M. L. Brenner, and K. J. Zuzek. 1985. Effective use of ethylene-releasing agents to prevent spread of eastern dwarf mistletoes on black spruce. *Canadian Journal of Forestry Research* 15:872-876.
- Moinat, A. 1988. Chemical control of dwarf mistletoe of pine. Progress Report for 1988. Estes Park, Colorado, Unpublished Report, 3 p.
- Nicholls, T. H., L. Egeland, F. G. Hawksworth, and D. W. Johnson. 1987a. Control of dwarf mistletoe with ethephon. Proceedings of the 34th Western International Forest Disease Work Conference, p. 78-85.
- Nicholls, T. H., L. Egeland, F. G. Hawksworth, D. W. Johnson, and M. K. Robbins. 1987b. Control of dwarf mistletoes with a plant growth regulator, p. 154-156, In: Proceedings of a Technical Conference on Management of Subalpine Forests: Building on 50 Years of Research, July 6-9, 1987, Silver Creek, CO. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-149.
- Quick, C. R. 1962. Summary of experiments on direct chemical control of some forest diseases in western North America. Proceedings of the Tenth Western International Forest Disease Work Conference, p. 93-98.
- Robbins, M. K., D. W. Johnson, F. G. Hawksworth, and T. H. Nicholls. 1989. Aerial application of ethephon is ineffective for controlling lodgepole pine dwarf mistletoe. *Western Journal of Applied Forestry* (In press).
- Quick, C. R. 1964. Experimental herbicidal control of dwarfmistletoe on some California conifers. USDA Forest Service, Research Note PSW-47, 9 p.
- Scharpf, R. F. 1972. Summation of tests for chemical control of dwarf mistletoe. Proceedings of the Nineteenth Western International Forest Disease Work Conference, p. 80-83.

II. CHEMISTRY, MODE OF ACTION, SAFETY, USES, AND REGISTRATION STATUS OF ETHEPHON FOR DWARF MISTLETOES.

Thomas E. Vrabel

ABSTRACT: The CHIPCO^R FLOREL^R PRO brand Plant Regulator formulation of ethephon provides excellent abscission of dwarf mistletoe in conifers and leafy mistletoe in deciduous trees when applied in spray concentrations of 2500-2700 ppm. Proposed label additions and research emphasis with this product in 1989 are discussed.

INTRODUCTION

Mistletoes are one of the most damaging tree parasites in the United States. In ornamental and recreational areas, dwarf and leafy mistletoe infestations are an unattractive nuisance and a leading cause of tree loss. Ethephon has been found to be very effective in causing the abscission of dwarf and leafy mistletoe shoots and thereby preventing spread via seed production and dispersal to uninfected trees.

MODE OF ACTION

The activity of ethephon (2-chloroethylphosphonic acid) as plant regulator lies in its ability to release ethylene when absorbed into plant tissues. It undergoes a base catalyzed elimination reaction and decomposes into ethylene, chlorine, and phosphonic acid. This reaction occurs at pH levels greater than 4.1 and the rate of ethylene evolution increases with increasing pH.

RESEARCH SUMMARY

Over the past five years extensive research has been conducted by Rhone-Poulenc Ag Company, United States Forest Service, and university personnel on dwarf and leafy mistletoe species removal with ethephon (table 1). Results from this research show that conifer treatment with 2500 ppm of ethephon 2 to 3 weeks prior to dwarf mistletoe (*Arceuthobium* spp.) seed dispersal provided 94% abscission of treated mistletoe shoots within 2 to 5 weeks after application (Fig. 1) (Fritz 1988). Since translocation of ethephon is minimal, uniform spray coverage is required to obtain these high rates of abscission. Research conducted in 1988 indicates that excellent abscission can occur from applications made throughout the summer months. Ethephon does not kill the mistletoe endophytic system and resprouting can occur within a few months of application. Regrowth of mistletoe shoots occurs slowly and it is usually 3 to 5 years before treated infections will produce a significant number of seed.

Treatment of leafy mistletoe (*Phoradendron* spp.) with 2500 ppm spray concentrations of ethephon have provided in excess of 85% shoot abscission (Fig. 1). Optimal activity is obtained when applications are made from leaf drop until mid-winter. Applications made prior to tree bud break have not been as successful and higher rates are needed to obtain satisfactory mistletoe abscission. Abscission of both dwarf and leafy mistletoe is enhanced when a surfactant is added to the spray solution.

THOMAS E. VRABEL is Program Coordinator, CHIPCO Specialty Products, Rhone-Poulenc Ag Co., Research Triangle Park, North Carolina.

Table 1--Host tree and mistletoe species evaluated in ethephon studies.

<u>Host Species</u>	<u>Mistletoe Species</u>
Silver Fir	<u>Viscum album</u>
Black Spruce	<u>Arceuthobium pusillum</u>
Douglas-Fir	<u>Arceuthobium douglasii</u>
Lodgepole Pine	<u>Arceuthobium americanum</u>
Jack Pine	<u>Arceuthobium americanum</u>
Ponderosa Pine	<u>Arceuthobium vaginatum</u>
Black Walnut	<u>Phoradendron macrophyllum</u>
Eastern Moraine Ash	<u>Phoradendron macrophyllum</u>
Oak	<u>Phoradendron tomentosum</u>
Elm	<u>Phoradendron tomentosum</u>

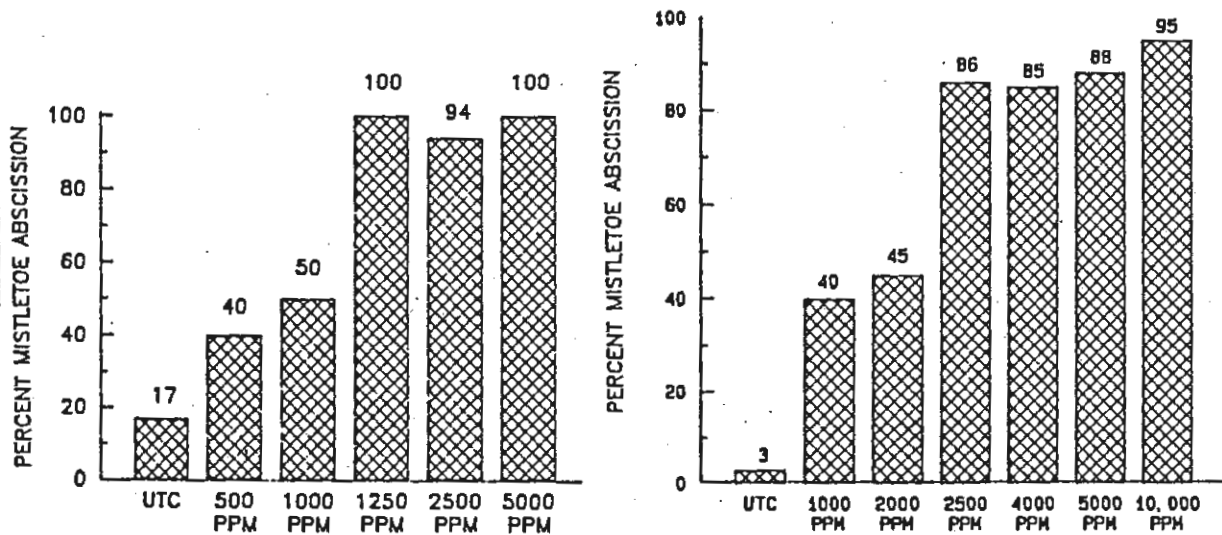


Figure 1. Summaries of ethephon tests for dwarf mistletoes (Left) and leafy mistletoes (Right). UTC = untreated controls.

FORMULATIONS

Rhone-Poulenc Ag Company has two ethephon formulations currently registered for dwarf mistletoe shoot removal. CHIPCO[®] FLOREL[®] PRO brand Plant Regulator contains 2.0 pounds of ethephon per gallon and is for professional use. Application rate for dwarf mistletoe shoot removal is 5 quarts of CHIPCO[®] FLOREL[®] PRO per 100 gallons of water and provides a spray solution containing 2700 ppm of ethephon. FLOREL[®] brand Plant Regulator contains 0.33 lbs ethephon per gallon and is for use by the general public. Application rate for dwarf mistletoe shoot removal is 1 quart of FLOREL[®] per 4 gallons of water and provides a spray solution containing 2500 ppm ethephon.

REGISTRATION STATUS

In 1989 Rhone-Poulenc Ag Company will pursue addition of leafy mistletoe removal to the registrations of the FLOREL[®] products and will expand the dwarf mistletoe application window to include the summer months prior to seed dispersal. California registration of both products for dwarf and leafy mistletoe shoot removal will also be pursued in 1989.

RESEARCH EMPHASIS

Research efforts in 1989 will attempt to broaden the range of information available on the efficacy of ethephon for mistletoe shoot removal. Dwarf mistletoe research will concentrate on further definition of the application window and will investigate use rates on tree species (such as larch and Douglas-fir) whose sensitivity to ethephon may differ from that exhibited on trees such as lodgepole pine and ponderosa pine. Leafy mistletoe efforts will investigate applications on live oaks, attempt to further define the fall/winter application window, and investigate the feasibility of injection applications for use in residential areas.

LITERATURE CITED

Fritz, C. D. 1988. Abscission of dwarf mistletoe shoots with ethephon. Proceedings Plant Growth Regulator Society of America (in press).

III. ETHEPHON TESTS FOR LODGEPOLE PINE DWARF MISTLETOE IN COLORADO.

Thomas H. Nicholls

This paper summarizes test results of ethephon, an ethylene-releasing plant growth regulator, as a control for Arceuthobium americanum on Pinus contorta on the Arapaho National Forest in Colorado. The objective of the study was to determine the effectiveness of ethephon as a dwarf mistletoe control and, if successful, determine the duration of its control.

Ethephon, at a rate of 2500 ppm in water with a surfactant, was applied during August to lodgepole pine with a bottle sprayer in 1983, a back pack mist blower in 1984, and a hydraulic sprayer in 1985. Ethephon applications were very effective in causing shoot abscission, but it did not kill the dwarf mistletoe endophytic system. Dwarf mistletoe shoot abscission rates of 78 to 100 percent were consistently achieved within 2 to 5 weeks using the three application methods (Nicholls et al. 1987a; 1987b). Helicopter sprays in 1986 and 1987 were ineffective because not enough ethephon came in contact with mistletoe shoots to cause abscission (Robbins et al. 1989).

Duration of control was determined by the use of mistletoe seed traps and by observing all female shoots each year that had 100 percent abscission until they once again produced berries.

THOMAS H. NICHOLLS is Wildlife Project Leader with the USDA Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Mistletoe seed traps were placed along transects through treated and untreated areas in the hydraulic spray study areas on the Fraser Experimental Forest (N=20) and the Cutthroat Bay Campground (N=31). Traps were used for various periods during seed dispersal for 4 years; first year before abscission and 3 years after abscission. Prior to shoot abscission, there was little difference in seed dispersal in areas selected for controls and ethephon treatments. After treatment, there was a major reduction in seed dispersal in ethephon-treated areas for 2 years at the Fraser Experimental Forest and for 3 years at the Cutthroat Bay Campground (Fig. 1). Natural shoot abscission in the Fraser Experimental Forest control area may explain why more seeds were trapped in the control area than in the treated area in 1988. It follows that a major reduction in seed dispersal undoubtedly reduced infection.

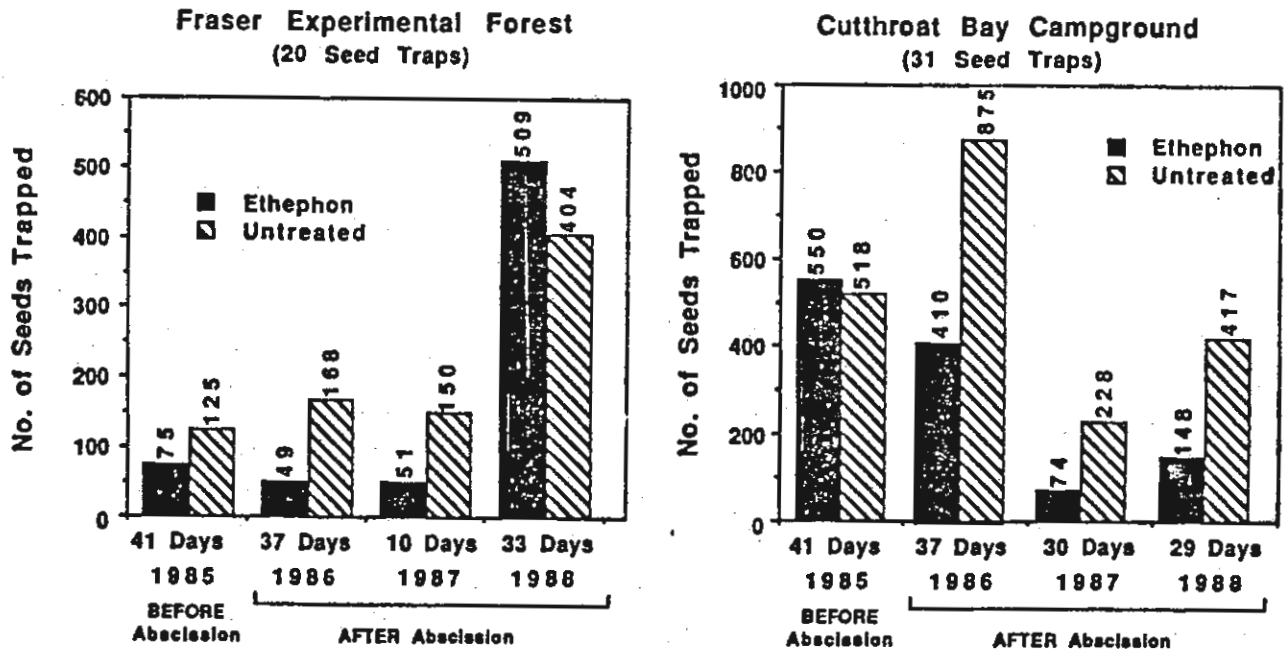


Figure 1. Number of dwarf mistletoe seeds trapped before and after shoot abscission during annual seed dispersal periods in ethephon-treated and untreated areas.

To determine duration of control using another method, female infections were followed from 1 to 5 years after treatment (Fig. 2). Readings were made each year on individual female infections that had 100 percent abscission after treatment to determine when berries might first appear again. The percent of female infections developing new shoots with berries steadily increased from three percent after 2 years to 52 percent 5 years after treatment at which time the study was concluded. Even after 5 years, berry production of ethephon-treated infections was only a few hundred compared to untreated infections where berries were too numerous to count. The fate of individual female infections with 100 percent abscission after 5 years was interesting.

Some infections did not develop any new shoots; some developed new shoots and berries only at the margins of original infections; some infections developed new shoots and berries over all the previously infected tissue.

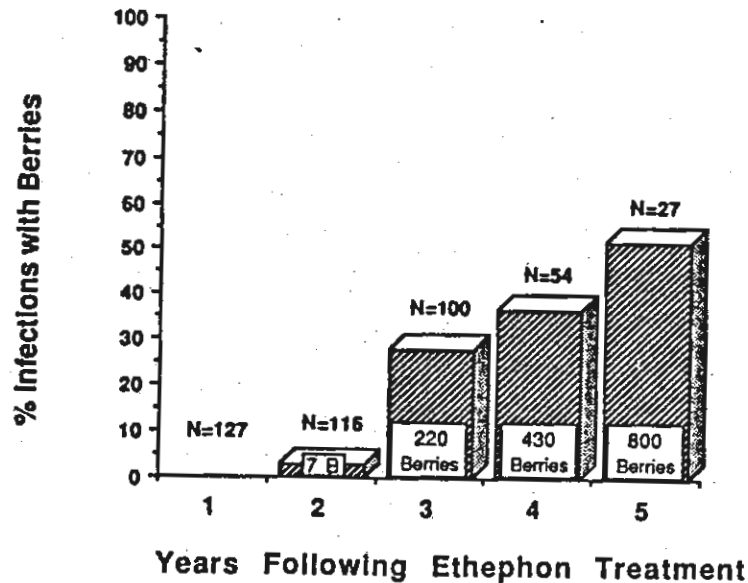


Figure 2. Yearly percent of female infections with newly developed berries following complete shoot abscission and approximate number of berries observed.

CONCLUSIONS

1. Ethephon does not kill dwarf mistletoe, but it does cause significant shoot abscission leading to a reduced spread and intensification of the disease.
2. Ethephon must make direct contact with shoots to cause abscission.
3. Bottle, back pack, and hydraulic ground spray methods were effective; aerial sprays were not effective.
4. Seed and berry production were substantially reduced for up to 4 years after ethephon treatment at 2500 ppm with a surfactant.
5. Ethephon re-application should be considered in the 5th year to eliminate newly developing shoots and berries.

Ethephon shows promise as an effective, safe, and economical way to reduce the impact of dwarf mistletoe in high value stands. It will also provide forest managers with another control option to use in conjunction with other effective silvicultural control methods.

LITERATURE CITED

- Nicholls, T. H., L. Egeland, F. G. Hawksworth, and D. W. Johnson. 1987a. Control of dwarf mistletoe with ethephon. Proceedings of the 34th Western International Forest Disease Work Conference, p. 78-85.
- Nicholls, T. H., L. Egeland, F. G. Hawksworth, D. W. Johnson, and M. K. Robbins. 1987b. Control of dwarf mistletoes with a plant growth regulator. p. 154-156, In: Proceedings of a Technical Conference on Management of Subalpine Forests: Building on 50 Years of Research, July 6-9, 1987, Silver Creek, CO. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-149.
- Robbins, M. K., D. W. Johnson, F. G. Hawksworth, and T. H. Nicholls. 1989. Aerial application of Ethephon is ineffective for controlling lodgepole pine dwarf mistletoe. Western Journal of Applied Forestry (In press).

IV. ETHEPHON TESTS FOR PONDEROSA PINE DWARF MISTLETOE IN COLORADO.

David W. Johnson and Diane M. Hildebrand

Two tests of ethephon have been conducted in Colorado on southwestern dwarf mistletoe, Arceuthobium vaginatum subsp. cryptopodum. The first large scale application was with a Solo Mist Blower (R) to ponderosa pine at the Manitou Experimental Forest, near Colorado Springs, CO in June 1987 (Johnson and Hawksworth 1988). Ethephon was applied at the rate of 2500 ppm in water with spreader-stickers Nu-Film 77 and Spray-Aide (0.1%) Miller Chemical and Fertilizer Corp. Controls consisted of the spreader-stickers alone in water. Abscission of dwarf mistletoe shoots was assessed by direct observation and counting shoots on tagged localized infections 5 weeks after treatment. Reduction in numbers of shoots in controls was 2%; whereas for treated shoots it was 57% (Table 1). The following year, shoot abscission was 16% in controls and 63% for treated shoots. The poor rate of abscission in the treated shoots was attributed to inadequate coverage of the mistletoe plants using the Solo Mist Blower, which has low pressure and volume.

The second, larger test was made in mid-June, mid-July and mid-August 1988 on infected ponderosa pine in the Black Forest near Colorado Springs, CO. Application was made by hydraulic sprayer by a commercial applicator. Rates evaluated included 0, 2200, and 2700 ppm ethephon in water with Ortho X-77 spreader-sticker (R) at 0.1%. Results of shoot abscission were recorded 4 weeks after each application. Shoot abscission varied slightly with time of treatment ranging from 73 to 98 % (Table 2). Natural abscission rates were fairly high reaching 14 % in the mid-July application. Much insect activity was noted including feeding by larvae of the butterfly Mitoura spinetorum. Development of new shoots was occurring after mid-August.

DAVID W. JOHNSON and DIANE M. HILDEBRAND are forest pathologists with the USDA Forest Service, Rocky Mountain Region, Timber, Forest Pest, and Cooperative Forestry Management, Lakewood, Colorado.

Additional evaluations of both tests will be conducted yearly until development of mature mistletoe shoots and fruits occurs.

Table 1. Results of ethephon trials with a Solo Mist Blower for dwarf mistletoe on ponderosa pine, Manitou Experimental Forest, Colorado, 1987.

Treatment	Examination date	
	6/87	6/88
	Percent reduction in shoots	
Controls	2	16
2500 ppm	57	63

Table 2. Results of ethephon applied by hydraulic sprayer at monthly intervals for dwarf mistletoe on ponderosa pine, Black Forest, Colorado, 1988.

Treatment	-----Application Date-----		
	mid-June	mid-July	mid-August
	Percent change in number of shoots after 4 weeks		
Controls	0	-14	+16
2200 ppm	-87	-84	-73
2700 ppm	-86	-98	-93

LITERATURE CITED:

Johnson, D. W., and F. G. Hawksworth. 1988. Reduction of ponderosa pine dwarf mistletoe with the plant growth regulator ethephon. USDA Forest Service, Rocky Mountain Region; Timber, Forest Pest, and Cooperative Forestry Management, Technical Report R2-42, 10 p.

V. ETHEPHON TESTS FOR PONDEROSA PINE DWARF MISTLETOE IN NEW MEXICO.

Jerome S. Beatty, Helen Maffei, Edward Collins, and Monty Christian

Tests were made on Southwestern dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) at the Los Alamos National Laboratory (LANL), near Santa Fe, New Mexico. Two concentrations of ethephon were sprayed on dwarf mistletoe-infected ponderosa pines to determine if this chemical would cause abscission of dwarf mistletoe plants. Applications of ethephon to cause abscission of dwarf mistletoe shoots have been successful for several coniferous species including black spruce, ponderosa pine, and lodgepole pine. (see other papers in this panel).

METHODS AND MATERIALS

We established three spray areas: two tests of 25 trees each sprayed with ethephon and a control block of 25 trees sprayed with water only. The ethylene-releasing chemical ethephon was applied to infected trees in two areas using a trailer-mounted, hydraulic, hand-jet sprayer. The spraying was done by Pan Am, a commercial contractor responsible for all Lab maintenance and groundskeeping, on the morning of August 31, 1987. We did not use a spreader-sticker in any of the three formulations. The ethephon was applied carefully to the mistletoe plants, using water as a carrier. One area was sprayed with 2500 ppm (1 gallon of Etherel in 200 gallons of water), with one area with 1200 ppm (2 quarts of Etherel in 200 gallons of water), and the third area with 200 gallons of water.

The treated trees ranged from 18 to 50 feet high and averaged about 20 feet, and averaged about 8 inches d.b.h. Five mistletoe infections from each treatment were chosen at random and rated before and after treatment using the Dwarf Mistletoe Area Grid Rating System (DMAGRS), developed by Nicholls et al. (1987). We also recorded the number of visibly infected branches in each tree and rated each tree using the 6-class Dwarf Mistletoe Rating System (DMR) (Hawksworth 1977).

RESULTS AND DISCUSSION

The trees were examined 30 days after treatment, on 1 October, 1987. The five individual infections that were tagged and photographed in each treatment showed good results for the ethephon sprays:

JEROME S. BEATTY and HELEN MAFFEI are forest pathologists with the USDA Forest Service, Southwestern Region, Forest Pest Management, Albuquerque, New Mexico. EDWARD COLLINS is Forest Ranger with the USDA Forest Service, Apache-Sitgreaves National Forest, Lakeside, Arizona. MONTY CHRISTIAN is with the Rhone-Poulenc Ag Co., Lubbock, Texas.

Treatment	Average abscission (DMAGRS) based on five dwarf mistletoe plants in each treatment
Water only	8%
1200 ppm Ethephon	72%
2500 ppm Ethephon	92%

The 2500 ppm treatment had very few shoots remaining one month after spraying. The 1200 ppm block showed somewhat less abscission, and the results were much more variable. The controls showed little or no change. The DMR's of individual trees did not change much even though the raters were told to base ratings only on visible plants, probably because too much bias is built in to the system as the raters "know" that trees are infected and rate accordingly. Also, many of the dead, abscised shoots remained attached to the branches and could have been mistaken for live infections. The lack of change in the number of infected branches suffers from the same limitations. However, these two methods of quantifying results will probably be more useful over the long term to see if spraying can prevent the increase of intensity of dwarf mistletoe plants in infected trees. The trees will be examined and photographed again in 1988 and each year for the next 5 years.

LITERATURE CITED:

- Hawksworth, F. G. 1977. The 6 class dwarf mistletoe rating system. USDA Forest Service, General Technical Report RM-48, 7 p.
- Nicholls, T. H., L. Egeland, F. G. Hawksworth, and D. W. Johnson. 1987. Control of dwarf mistletoe with ethephon. Proceedings 34th. Western International Forest Disease Work Conference, p. 78-85.

VI. ETHEPHON TESTS FOR DOUGLAS-FIR, LARCH, AND PONDEROSA PINE DWARF MISTLETOES IN THE NORTHWEST.

Catherine Parks and James T. Hoffman

- Ethephon tests are underway for the following dwarf mistletoes and hosts:
1. Arceuthobium douglasii on Pseudotsuga menziesii, Wallowa-Whitman National Forest, Oregon, 1987. Thirty infections each were sprayed at concentrations of 1250, 2500, and 5000 ppm ethephon plus 0.1% surfactant (Product R-11, Wilbur-Ellis Co.). The results after 1 year are as follows:

CATHERINE PARKS is forest pathologist with the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, LaGrande, Oregon. JAMES T. HOFFMAN is forest pathologist with the USDA Forest Service, Intermountain Region, Forest Pest Management, Boise, Idaho.

Ethephon Rate	Dwarf Mistletoe Shoot Abscission	Twig Dieback Percent	Twig Death	Mistletoe shoot Regrowth
1250	100	Trace	0	37
2500	99	24	4	7
5000	98	41	11	0

Thus, high shoot abscission rates were obtained with all dosages, but damage resulted to the host twigs with the higher dosages. The occurrence of systemic witches' brooms associated with this mistletoe may be related to the high twig mortality found in Douglas-fir. Mistletoe shoots resprouted in the tests with the lower dosages.

2. Arceuthobium laricis on Larix occidentalis, Wallowa-Whitman National Forest, Oregon, 1988. Thirty plants were sprayed with 2500 ppm ethephon and 0.1 % X-77 surfactant and 30 plants sprayed with the surfactant only. After 1 month 99 % of the mistletoe shoots abscised and 2 % of the sprayed plants showed some re-sprouting.
3. Arceuthobium campylopodum on Pinus ponderosa, Boise National Forest, Idaho, 1988. Thirty plants each were sprayed in 4 tests: 2500 ppm ethephon and 0.1 % X-77 surfactant and the surfactant only on July 13 and on August 7. The 2-month results for the July test showed 94 % mistletoe shoot abscission but 55 % of the sprayed plants had resprouted. The 1-month results for the August test showed 84 % mistletoe shoot abscission but 76 % of the sprayed plants had resprouted.

High dwarf mistletoe shoot abscission was obtained for most of the tests. The high mistletoe resprouting rates for ponderosa pine and the 1250 ppm test for Douglas-fir are surprising but it should be noted that the resprouting to date refers only to small "nubbins" and further observations on these tests will be needed to determine when mistletoe seed production begins.

VII. ETHEPHON TESTS FOR DWARF MISTLETOES IN CALIFORNIA.

Susan Frankel and David Adams

ABSTRACT: Ethephon (Florel), an ethylene-releasing plant growth regulator, was applied to dwarf mistletoe shoots on 3 California conifers: Arceuthobium campylopodum on Pinus ponderosa (Boggs Mountain State Forest) and P. jeffreyi (Latour State Forest) and Arceuthobium americanum on Pinus contorta (Latour State Forest) in August and September, 1988. Ethephon at rate of 2500 ppm with a surfactant (Ortho X-77) and Ortho-X-77 and water was applied using a backpack sprayer to about 30 plants of each host-parasite combination. The results after 5 weeks showed high shoot abscission rates:

SUSAN FRANKEL is forest pathologist with the USDA Forest Service, Pacific Southwest Region, Forest Pest Management, San Francisco, California. DAVID ADAMS is forest pathologist with the California Department of Forestry and Fire Protection, Sacramento.

Dwarf Mistletoe and Host Shoot Abscission after 5 weeks.

<u>Arceuthobium campylopodum</u> - <u>Pinus ponderosa</u>	99%
<u>Arceuthobium campylopodum</u> - <u>Pinus jeffreyi</u>	97%
<u>Arceuthobium americanum</u> - <u>Pinus contorta</u>	100%

There was some damage to host foliage, particularly to older needles of Pinus contorta.

VIII. CONTROL OF LEAFY MISTLETOE (PHORADENDRON TOMENTOSUM) WITH ETHEPHON.

Ann Marie Wiese

ABSTRACT: Mistletoe abscission rates on cedar elm sprayed February 20, 1988 were 80% for 4200 ppm ethephon/surfactant, 55% for 2100 ppm/surfactant and 33% for 2100 ppm ethephon alone. Percent abscission in a post oak trial with 2 spray timings ranged from 85 to 95% at 5000 ppm ethephon/surfactant and 85 to 63% with 2500 ppm/surfactant.

INTRODUCTION

Leafy mistletoe infestations in Texas are viewed as a commercial boon or menace. The biggest harvests of mistletoe for Christmas celebrations occur in Central Texas, but the overabundance of the pest deem that harsher control methods may be warranted. People most interested in commercial control of leafy mistletoe include city park supervisors, county and state extension agents, golf course managers, and commercial applicators and dealers.

Dr. George Philley and Dr. Jerrel Johnson are Extension Plant Pathologists with Texas A & M University and these gentlemen have worked with ethephon to control mistletoe longer than anyone in the state. This paper will discuss research trials from 1987 and 1988 by four other researchers, including the author, Dr. Ricks Pluenneke, a private consultant, plus Randy Petterson and John Cooper of Denton, Texas.

METHODS AND DISCUSSION

Three different trials for control of leafy mistletoe (Phoradendron tomentosum) were conducted. The first trial was sprayed with a commercial rig on hackberry by Randy Petterson, the Parks Supervisor of Denton, Texas. Ethephon at 4200 ppm + X-77 surfactant was sprayed February 23, 1988 either once or twice. The double applications were sprayed 15 minutes apart, giving the mistletoe clumps time to dry. The single applications were not commercially acceptable, but the double applications showed 80% abscission.

The trial by Dr. Ricks Pluenneke had two spray dates, January 21 and March 6, 1988 and two ethephon rates, 2500 and 5000 ppm. A surfactant, Ortho X-77, was tank mixed with ethephon in a trombone sprayer. Control with 5000 ppm

ANN MARIE WIESE is with the Field Research and Development unit of Rhone-Poulenc Ag Co., Plano, Texas.

ethephon/X-77 ranged from 85 to 95%. The lower rate was less consistent with 86 to 63% control. Abscission levels obtained after the January spray were overall slightly higher than March sprays (table 1).

A third trial was sprayed on cedar elm which were close to bud break. ethephon rates evaluated were 2100 ppm with or without a surfactant (.05%), 3150 ppm + surfactant and 4200 ppm + surfactant. The surfactant addition to 2100 ppm ethephon improved mistletoe abscission from 33 to 55% after one month. The high rate, 4200 ppm ethephon showed 80% abscission after one month and 51% after two months (table 2).

DISCUSSION

Mistletoe abscission rates varied between trials. This variability could be caused by interactions between weather, spray application and techniques, host tree/mistletoe interactions and more. However, it seemed that mistletoe on trees close to bud break was more difficult to kill than mistletoe on a dormant tree. This problem could sometimes be overcome by higher rates (such as the double application), but a better solution would be to start the rate x timing studies right after frosts have taken the tree leaves off. Then mistletoe might be dead by the time birds normally spread the mature seeds in mid-January to mid-February. These trials demonstrated that addition of a surfactant improved mistletoe control. Further investigations should be concentrated on rate x timing studies and additive studies to determine the best spreader sticker system.

Table 1--Percent mistletoe abscission from post oak trees.

Ethephon rates	Spray dates			
	1/21/88 1 Mo.	6 Mo.	3/6/88 1 Mo.	5 Mo.
---Percent Mistletoe Abscission---				
2500 ppm + X-77	86	74	80	63
5000 ppm + X-77	85	91	93	95

Table 2-- Mistletoe abscission from cedar elm sprayed on February 20, 1988.

Ethephon Rates	Percent Mistletoe Abscission	
	1 Month	2 Months
2100 ppm	33	15
2100 ppm + surfactant (.05%)	55	29
3150 ppm + surfactant (.05%)	55	24
4200 ppm + surfactant (.05%)	80	51

IX. CONCLUSIONS

David W. Johnson and Frank G. Hawksworth

In September 1987, the EPA approved the growth-regulator Florel TM (active ingredient ethephon) for reducing the spread of dwarf mistletoe (Arceuthobium spp.). This is the first registered use of any chemical for the dwarf mistletoes. Although ethephon has been tested on dwarf mistletoes for at least 15 years, its intensive testing and active development has only been over the past 5 years.

Ethephon does not provide long-term dwarf mistletoe control but, by causing mistletoe shoot abscission, it can substantially reduce the spread of the parasite. The growth-regulator seems to have little effect on the mistletoe's root system within the cortex and wood of the host branch or trunk. Thus, the effects of the growth regulator are temporary and new shoots, and eventually new fruits, will develop from the living mistletoe root system. The effective time of seed reduction is poorly known at present, but seems to vary from 2 to 4 years or so, depending on the mistletoe species and the locality.

Ethephon can be used to reduce dwarf mistletoe spread and to protect understory trees adjacent to infected overstory trees. Treatment of infected stands without an understory to protect is not recommended. Treatment will be essentially limited to trees in high value areas, i.e, recreation areas, administrative sites, home sites, etc.

Ethephon has been, or is being, tested on at least 8 dwarf mistletoe host-parasite combinations:

- Arceuthobium americanum on Pinus banksiana (Manitoba)
- Arceuthobium americanum on Pinus contorta (Colorado, California)
- Arceuthobium campylopodum on Pinus ponderosa (California, Idaho)
- Arceuthobium campylopodum on Pinus jeffreyi (California)
- Arceuthobium divaricatum on Pinus edulis (New Mexico)
- Arceuthobium douglasii on Pseudotsuga menziesii (Oregon)
- Arceuthobium laricis on Larix occidentalis (Oregon)
- Arceuthobium vaginatum on Pinus ponderosa (Colorado, New Mexico)

Preliminary results from these tests look promising and shoot abscission rates of 90 to 100 percent have resulted for most tests where thorough coverage of the dwarf mistletoe shoots has been achieved. The tests established are being followed to determine the extent of re-sprouting and when mistletoe seeds are re-produced. To date only ground application has been successful. There has been limited premature browning of older host needles in some tests.

Tests have been conducted with ethephon on two species of leafy mistletoes of the genus Phoradendron: P. macrophyllum on walnut and ash in California and P. tomentosum on oak, elm, and hackberry in Texas. We understand that tests with Phoradendron juniperinum on juniper are underway in New Mexico but we don't have any details. Tests with hardwoods have the advantage of being able to spray the evergreen mistletoes during the dormant season when the hosts have no foliage. Thus, higher dosages of the chemical can be used without host damage. In general, the results with the leafy mistletoes are similar to those with the dwarf mistletoes but the effects seem to be more variable. Further testing with the growth regulator is needed help explain the variation in effects.

The development of ethephon to limit dwarf mistletoe spread has been a cooperative effort between the Rhone-Poulenc Ag Company (formerly Union Carbide Agricultural Products Co., Inc.); the University of Minnesota Department of

Plant Pathology; USDA Forest Service Research Stations (North Central, Rocky Mountain, and Pacific Northwest); USDA Forest Service Forest Pest Management Units (Rocky Mountain, Southwestern, Pacific Southwest, and Intermountain Regions); the Colorado State Forest Service; and the Manitoba Department of Natural Resources.

NOTE: The mention of products and companies by name does not constitute endorsement by the Western International Forest Disease Work Conference or the U. S. Department of Agriculture, nor does it imply approval of a product to the exclusion of others that may also be suitable.

PUBLIC INVOLVEMENT IN FOREST HEALTH - WHO WILL SPEAK?

A Panel

John G. Laut, Moderator

INTRODUCTION

The need for members of WIFDWC to be involved with the public has been a long-standing issue, discussed at many previous meetings. The particular genesis of this panel was here in Park City in March 1987, at the Western Forest Insect Work Conference during a panel discussion of the apparent decline in our "profession".

The subject was further focussed by two editorials in Plant Disease: "The Status of Support for Forest Pathology Research" by Arthur Kelman, May, 1987 (Vol.71, p.387); and "Merchandising Plant Pathology" by C. Wendell Horne, December, 1987 (Vol.71, p.1064). Kelman pointed out the need to inform "influential scientists and public officials and administrators" of the need for improved support.

Horne pointed out that we (whether research or applied scientist) produce tangible products and goods that must be marketed and that this will happen only "when we--individually and collectively--deliberately invest sufficient time and effort to sell our services and the need for them to the consuming public."

Why should we, busy as we are, take time out to get involved with the public? Surely they know how good we are for them. Dr. Jean Mater in 1977, published a short book entitled "Citizens Involved: Handle With Care, a forest industry guide to working with the public" (Timber Press, Forest Grove, Oregon). I quote: "The public includes people who exercise their citizenship power rarely if at all. This amorphous group, any part of which may suddenly coalesce into action, may appear on the scene only on election day. They tend to be followers rather than leaders but are no less powerful."

Note the phrase "may suddenly coalesce into action".

To continue from Mater- "... industry as well as institutions, continue to function only by public consent. (emphasis added) ...the public, led by articulate activists is feeling its power, flexing its muscles and using its power of consent."

Sooner or later you will do what your boss wants. Sooner or later you will have only one viable option -- educate your boss to want the "right" things.

If our profession, or science, is losing public support, we must become ARTICULATE ACTIVISTS to lead the public (our real boss) into action -- to exercise its power of consent in our favor.

Why? We exercise a public trust. The public is involved in what we do. We must get involved with them in helping them decide what they want. Our only market place is that public arena.

What do we sell? This can be complicated and sometimes confusing. The public is made up of many different audiences (subgroups). Each audience may need and will only listen to a different message. Just as there are many needs, the answers come in many different themes.

Here we, as a group, must be careful. I believe there is a need for some thoughtful orchestration to ensure those different themes emerge in harmony. Our efforts must be unified.

I suggest a focal point for such efforts is the Forest Health Initiative put forth by the Chief of the US Forest Service in 1988.

Where do we need to get involved in such activities. Where do we find customers? Where can we find audience, or more properly, where must we find audience. What arenas can we find in which to operate?

The following three papers each focus on a particular arena: academics, forest managers, and the research arena.

I want to spend some of your time on the political arena. There are 2 ways in which we as a group, and as individuals can operate in the political arena. The first is through organizations of which we all are members (at least collectively). SAF, CIF, APS, CPS, AFA, WPCA, NASF, Audubon, Sierra, Rotary, Lions etc. especially at the local club or chapter level.

The key word here is activity. All these kinds of organizations have subgroups that need to hear from you. They all have political influence. If you will participate, speak out, you will be surprised how easy it is to lead them to a position--get them to go where you want them to go!

This kind of political activism is highly effective and the individual comfort level is high. The relative anonymity of the individual is assured.

The second way is the individual approach. The target here is the individual legislator at local, State or federal level. As a citizen you have the right of access to your elected representatives. Never let a bureaucrat tell you different!

The job is the same: identify forest health issues that demand legislative (even if only for budgets) attention. Provide facts and suggest direction for the attention.

At the 1987 Western Forest insect Conference at Flagstaff we listened to a full time lobbyist for forestry affairs from Washington DC speak about influencing federal legislators. Her main message was that on any issue Congressional people generally are starved for facts and pertinent information!

Now I have met many Politicians and I don't believe I ever met a stupid one, but I have met many that were ignorant (lacking specific factual information), especially about forests and forest health.

You must have an issue with identified constituents. From the point a politician needs facts pertinent to the current situation and alternatives to resolve the issue.

I suggest, as has Jim Space earlier in this meeting, that the current issue for us is Forest Health.

Our best constituent these days is the recreationist. Recreation demands healthy forests. We are the experts in Forest Health, even with our own specialties. If we don't advertise and market our products and our services we won't get, and don't deserve, their support.

At Pingree Park, several years ago, I challenged you to take a politician to lunch. I reissue that challenge--you may be surprised.

The last arena to be discussed is in many ways the most important; The General Public. Also in many ways it is the most difficult because of the myriad of interests represented. The different themes needed to address the various interests present a real danger of producing a cacophony. Orchestration of our themes can however ensure a symphony, or at least a harmonious collection of thoughts.

Judicious use of the media, public appearances (service clubs, social clubs etc.), and even parades can get our products into the public market place.

We, as a profession, have done some good things. We must highlight the positive. Our message must reflect adn efect on the quality of life of each audience. Do we, can we, affect that quality?

We all must take responsibility. Our title question can only be answered by each of us.

When will this membership take an active role in developing and coordinating a strong merchandising program for our profession?

Will be those "articulate activists" that causes the PUBLIC to "COALESCE INTO ACTION" or will we continue to meet and moan each year until we are no longer?

Our best constituent these days is the recreationist. Recreation demands healthy forests. We are the experts in Forest Health, even with our own specialties. If we don't advertise and market our products and our services we won't get, and don't deserve, their support.

At Pingree Park, several years ago, I challenged you to take a politician to lunch. I reissue that challenge--you may be surprised.

The last arena to be discussed is in many ways the most important; The General Public. Also in many ways it is the most difficult because of the myriad of interests represented. The different themes needed to address the various interests present a real danger of producing a cacophony. Orchestration of our themes can however ensure a symphony, or at least a harmonious collection of thoughts.

Judicious use of the media, public appearances (service clubs, social clubs etc.), and even parades can get our products into the public market place.

We, as a profession, have done some good things. We must highlight the positive. Our message must reflect adn efect on the quality of life of each audience. Do we, can we, affect that quality?

We all must take responsibility. Our title question can only be answered by each of us.

When will this membership take an active role in developing and coordinating a strong merchandising program for our profession?

Will we be those "articulate activists" that cause the PUBLIC to "COALESCE INTO ACTION" or will we continue to meet and moan each year until we are no longer?

AN ACADEMIC PERSPECTIVE

Dick Parmeter

- 51 -

Asking me to speak on ways to gain public involvement in and support for forest disease protection and research is rather like asking Custer how to deal with Indians. If I had any good ideas, I would have an impressive research program teeming with graduate students, postdoctorates, and technicians. My present program teems with one staff research associate and just enough funding for an occasional trip to the woods.

I'm handicapped in this presentation by John's somewhat vague instructions, which, while no doubt befitting my own mental processes, leave some questions about who the public is and by what means its members might become "involved". It is difficult to imagine any great public clamor or demonstration for increased attention to forest diseases. Marching crowds chanting "we shall overcome annosus" or "hell no, mistletoe" seem unlikely, no matter how persuasively we package our profession.

I'm also a bit dubious of the basic premise that we've lost public support - I don't think we ever had any. I don't think that the public is even aware of us. Every time my wife meets someone who asks about my job, "forest pathologist" is met with "what on earth is that?" She has developed a short explanation; but I don't think she's met enough people to affect in any major way the public's awareness of forest pathology.

Bob Scharpf expressed concern about a high percentage of the public who do not even know where Idaho is. I'm far more worried about legislators, administrators, and high-level bureaucrats who "don't know where Idaho is." These

are the people we need to reach. To the extent that we can enlist the help of the public in influencing these "keepers of the keys", we might obtain at least equitable treatment, but we need to develop some fresh channels. Old ones seem clogged.

I had the lugubrious experience of participating formally at three levels in the processes of setting research priorities for "Forests and Associated Rangelands" in the West: as a member of a "scientists" committee, as a secretary at a conference of "users" (upon which final priorities were to be primarily based, supposedly), and as a member of a committee to reconcile scientist and user (read public) priorities. I found it a doleful diddling of delegates. The pathology committee recommended 37 scientist years for forest pathology, "users" recommended by my calculations that 34% (62 sy) of the protection funds go to disease, and the reconcilers went with 25% (about 45 sy) for pathology. The final, official report recommended 29 sy for forest pathology (16% of the protection budget). Somewhere in the clouded and misty heights of bureaucracy, the opinions of scientists and the public were lost. No doubt our profession would be better off if we knew why - and what could be done about it.

Loud lamentations, rending of garments, or sackcloth and ashes probably won't help, although a memorable WIFDWC might result. A grand wake might also be memorable but premature. Rather, as John has instructed, we "need to talk about the apparent decline of interest and support for our efforts from your 'public' - reasons and possible solutions."

To begin (beginning at paragraph 7 is perhaps questionable), I'm convinced that a

decline in public interest is more appearance than reality. In the salad days of western pathology, a few good men (Meinecke, Weir, Boyce, et al.) covered the field. Much of their output would not be publishable today, lacking as it was in statistical and scientific elegance, but it served forest managers very well. The heydays of forest pathology, from which we decry decline, were a product of white pine blister rust, oak wilt, chestnut blight, Dutch elm disease, postwar euphoria, and a general belief in our inexhaustible capacity to support anything and everything. We have been inured by or have learned in some degree to live with these situations (or perhaps without them in the case of chestnut).

What did our heydays buy us? Control of blister rust? Control of Dutch elm disease? Control of oak wilt? Control of chestnut blight (no snickering, please)? In our catch words for the day, did we over promise and under deliver? I don't think we promised much, nor did we deliver much. Delivery may be our downfall. Elegant science produces papers, but it doesn't necessarily solve problems.

As an educator, I'm often embarrassed to stand in an annosus center with a group of students, silviculture trainees, park rangers, or other interested people. Usually they recognize quickly the key questions: How fast will the center enlarge? I don't know. Will incense cedars survive in fir centers? I don't know. How long does it take to kill a tree after it's infected? I don't know. Why don't you have answers to these questions? I think I can answer that one. We measure our success in neat, scientific papers, and we've assumed that that was the measure used by our supporters. I rather suspect that our supporters have measured our success by our answers to some simple but crucial questions

that do not lend themselves readily to short term, refereed-journal-type research. We may have sold our supporters piles of paper when they wanted practical prescriptions. I've no quarrel with basic research, but I think we have to gain support for such research the old-fashioned way - we have to earn it (or at least convincingly justify it).

We seem to have gone from salad days, to heydays, to "maydays". We need either further catastrophic introductions or a greater understanding of the importance and impact of "ordinary" diseases and how modern management affects these impacts. In addition, I think we need to recognize that "public" concerns do not necessarily coincide with commercial timber production.

As nearly as I have been able to judge over these many years of bemused fascination with public behavior, members of the public react mainly when issues affect them personally. The commonweal may get moral support, but the private weal gets financial support. Unfortunately for us, we tend to generalize disease impacts when we should personalize them. My graduate career (and those of many others) was financed by the U.S. distilling industry, not, I suspect, through any altruistic concern for oaks but because of threats to sources of tight cooperation.

Things happen when members of the public or land managers who represent them see threats to their special domains or find diseases complicating their management decisions. Perhaps our first responsibility is to ensure that potential supporters see clearly and vividly these threats, the possibilities to ameliorate them, and the information and logistics required. We need to show that we can deliver useful information and prescription.

My charge today is to discuss how academicians might contribute to the strengthening of our public and professional position. What is our place in this "sorry scheme of things entire" and what are our molding possibilities (this grammatical ambiguity may be appropriate)? I think we serve mainly as outsiders and as educators. Fairly or not, federal, state, and private pathologists are often perceived by the public (and by lawyers) as members of the "establishment" tied to politics and business. Professors are, of course, above all that, representing, as they do, pure truth and untainted objectivity. As "outsiders", professors can play an important role by providing a strong voice in support of increased forest pathology efforts. Perhaps we should be more actively noisy, or perhaps we should be called upon more frequently to run downfield interference.

Educationally, square one would seem to be assuring that all forestry graduates have a thorough grounding in forest protection. Realistically, when two such persuasive and eloquent protagonists as Fields and myself have been unable to convince our forestry faculty even to recommend, let alone require, forest pathology, what hope is there? The development of broader courses that appeal to conservation students (or even home economists, business administrators, and football players) is one possibility. Increasingly, "conservationists", rather than trained foresters, are influencing forest policy. We should see to it that this influence is soundly based.

I have also found it rewarding (both psychically and fiscally) to participate in training programs for state and federal park personnel, fire managers, and special interest groups (conservationists, arborists,

highway and city foresters, etc.). Such programs have been especially valuable when field trips were involved and obvious disease situations could be "touched".

There is also an important need for cooperation among disciplines. Recognition that fire, insects, and diseases participate inseparably in a grand ecological ménage à trois must lead to greater inclusion of pathologists in fire and insect work (and of course vice versa). At California, in both introductory and advanced courses, insect and disease materials have been combined, and we're proselytizing a fire specialist. All three disciplines should benefit from cooperative enterprises.

If I were to sum up these ramblings (and of course that's what I'm about to do), academically I'd recommend:

1. Pressing vociferously, albeit apparently futilely, for requiring pathology in forestry curricula;
2. Developing courses for conservationists and other non-foresters;
3. Seizing or even creating opportunities to tell professional and public groups about the nature and impacts of diseases;
4. Working with entomologists and fire specialists to foster integrated approaches to research and management - and integrated support;
5. Recognizing that urban, suburban, park, and recreational forest problems and concerns elicit public reaction and deserve professional attention. Spending some time on developing ways to reduce impacts and deal with problems in these areas should increase our stature in the public eye.

In addition to these rather - 54 -
platitudinous and prosaic proposals,
I might also suggest diffidently
that we explore the wild possibility
of developing as a group (maybe even
through WIFDWC) vehicles for
circulating press releases and for
providing newsletters for
legislators, administrators, and
appropriate public officials. Our
usual conditions reports are too
general, too dull, and too slanted
to the wrong audiences.

While I've never taken time to
do them, I think that articles for
National Geographic, Smithsonian,
Sunday Supplement, (OK Reader's
Digest, too) etc. would advance our
standing with the public and perhaps
evoke an occasional call for action.
Getting people to write such
articles is a problem.

I don't have any way to sum
this up. I had hoped for some flash
of inspiration that might impress
you with my perspicacity. The flesh
was willing, but the flash was weak.

PANEL: "PUBLIC INVOLVEMENT IN FOREST HEALTH - WHO WILL SPEAK?"

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

SEPTEMBER 23, 1988 - PARK CITY, UTAH.

SPEAKER: DAVE HOLLAND, GROUP LEADER
FOREST PEST MANAGEMENT, USFS
OGDEN, UTAH

I appreciate the opportunity to speak to you folks...especially on the topic of forest health. It's always enjoyable to have a vaguely defined topic permitting me to unload my opinions and conjecture on all of you. John Laut asked me to discuss forest health, specifically the area of "forest management."

The title for this panel, as you know, is "Public Involvement in Forest Health - Who Will Speak?" Let's discuss my view of the meaning of the term forest health. In the recent Forest Service publication entitled "Forest Health Report," the term was described as "a condition where biotic and abiotic influences on the forest do not threaten management objectives for a given forest unit either now or in the future." This definition covers all possible concerns and uses of forest lands. Our objectives in managing forest resources are product oriented whether the emphasis is wilderness, wildlife, timber, water, recreation, grazing, or whatever. And what is it we manage to achieve these commodity outputs...it's vegetation. The vegetation, and management of that vegetation, determines what resources we emphasize for that unit. The condition of the vegetation is critical to achieving the management goals for that unit. Many factors impact the health of that piece of land, including human activities, atmospheric deposition, climatic conditions, insects and diseases, etc.

We, as disease and insect specialists, certainly cannot address all these factors. However, forest pest infestations are often correlated with declining forest health. I think many of us would more appropriately describe the current perception of declining forest health as "advanced successional stages" in forest vegetation. However, we describe the ecological processes most of the forests in North America are undergoing; the public perceives the situation as unacceptable. They want to know what can be done to "heal" our forests. I think our first reaction as specialists might be to question the relative intelligence of the public, Congress, and many of our own administrators for their lack of understanding of natural forest processes. And following this reaction would be our traditional response...if you would ONLY support our programs, we might be able to answer and even prevent some of these adverse infestations. MAYBE both of these responses have some merit...but they do not answer the problem.

How do we create and maintain "healthy forests?" We know a great deal about what to expect throughout the life of a forest stand. That is, we know what factors, particularly pest infestations, will occur under a number of conditions. We can discuss stand susceptibility to disease...maybe not as definitively as we feel we need to, but certainly enough to let land managers know that an aspen or alpine fir in a developed site will only be viable for so

many years. And we can tell a land manager that lodgepole pine is a poor risk after 100 years due to mountain pine beetle. We have the basic information, but we haven't put that information into the hands of the general public. In my mind, the general public includes most forests managers when it comes to an appreciation for disease and insect interactions. Earlier this week Dale Bosworth gave a stimulating keynote address that emphasized a need for you specialists to try and understand the social needs of the public that drive management decisions. He also admitted that the need for understanding is a two-way street so to speak...that is, land managers need to make an effort to understand our message.

The forest health issue for the public, both internal and external, is simply a lack of understanding of the roles of forest diseases and insects within forest succession. And a subsequent lack of understanding of the need for specialists, and needed research and application programs, to more effectively manage our forest resources.

FOLKS, WE HAVE A SELLING/INFORMATION/EDUCATION PROGRAM TO DO or we will have a more limited future than we are presently experiencing. The article that John Laut asked all of you to read points to one aspect of the answer...start marketing forest pathology and increase the visibility. We need to develop educational programs on the role of forest diseases and insects in forest succession. We need to take the message to elementary schools, become active in local school curriculum to ensure ecological principles are being taught, develop field trips for the public, and simply provide the message to those you come in contact with. This year's fire situation is a good example of how to take advantage of an opportunity. I have been asked several times in the past few weeks by local folks about the Yellowstone fire situation. Many folks were simply asking questions to gain a better understanding, and some were very critical of what the Forest Service was doing...or not doing. Many folks do not understand the difference between the National Park Service and USDA Forest Service missions. In explaining the situation, I included a discussion of the role forest diseases and insects play in setting up forest conditions for support of catastrophic fires. I'm sure not everyone accepted my explanation, but hopefully they had a somewhat more informed viewpoint.

We need to get our "story" visible. We need to take the time in what we call the "press of business" to produce high quality general publications that are simple and easy to understand by the public.

More specifically, when it comes to our participation with National Forest land managers, we need to:

1. Invite ourselves to participate as ID Team members in the development of specific area vegetation management plans.
2. Review all land management planning documents to determine if each alternative action has adequately considered the short and long term impacts forest pests may have on management goals.

3. Understand the relationship of specific areas to the overall forest land management plan in order to develop pest management strategies that land managers can implement.

4. Accelerate the completion of models that allow us to simulate infestations and predict damage. Linking our pest models to a vegetation dynamics model such as PROGNOSIS, is the best opportunity we have for getting pests adequately considered in current planning efforts. These models will be invoked every time a user develops a prescription for a unit. The use of these models, with the incorporated pest subroutines, will serve to raise the level of understanding of insects and diseases.

5. Make sure vegetation management practices described in the Forest standards and guidelines are appropriate for attaining desired future conditions. We need to review silvicultural practices and prescriptions for adequacy in meeting described land management objectives.

6. Provide training and technical assistance designed to increase forest disease and insect awareness.

So back to the question "WHO WILL SPEAK?" You will speak...it's your responsibility to raise the level of awareness on the role of forest diseases in the environment. If you don't take the time to put your information in better, more appealing, and understandable packages...the chances of seeing more dollars for disease research and applications will become significantly reduced. We need to develop an informed public to support our efforts to investigate better methods for achieving forest health. The public needs to understand the trade-offs for the various management alternatives for a forest unit. Dale Bosworth, Forest Supervisor, Wasatch-Cache NF, in his keynote remarks, stated the case clearly..."don't tell me how to manage my land, tell me what options I have and what the consequences are for each alternative." I agree, however, we have a responsibility to tell the "Dales" which option is the best from our standpoint. When we make a recommendation, we must make it as simple and straight forward as possible without trying to second guess the land manager's objectives or "public opinion."

So, let's begin planning for our future and satisfy the general public's concern for forest health by increasing the public awareness for forest pests and their role in forest stand dynamics. Let's develop a more educated public so our peers in the future can enjoy a more supportive environment that provides a framework for needed research and application investigations and implementation.

It was Ralph Waldo Emerson that said "The future belongs to those who prepare for it."

Public Involvement in Forest Health - Who Will Speak?

Ed F. Wicker

In 1979, I received an invitation from Dr. Bart van der Kamp, Program Chairman, 27th Annual Western International Forest Disease Work Conference, Salem, Oregon, to participate in the conference and present my perceptions on the future of forest pathology research. In that address, I presented several statistics on forest disease research covering the 11-year period of 1969-1979 that I perceived to be indicators of decline in the profession and discussed some trends and events within that period that were contributing to our demise. In the following 10 years, the trends have not changed, many of the statistics have worsened, few persons, organizations, or institutions outside the profession project a concern, and the profession has not been able to reverse the situation. Now, ten years later, I have been invited back to address this assembly on the general subject of "Who will speak for Forest Health?"

Since all crystal balls are created equal, I will try a different approach in my discussion today. I will not bore you with an updating of gruesome statistics and trends indicative of decadence, but rather I wish to present some insights on some of the multiple factors affecting the profession's vitality, reassure you of the dire consequences if current trends continue, identify some actions that may restore the vitality of the profession, and suggest who is responsible for the health and well-being of the profession. I will attempt to accomplish this by relating to you the way I see things based on my imprinting, experiences, beliefs, and visions. Please remember, this may not be the way things are, but the way I see them. I hope you will analyze my perceptions with respect to your values, exercising your right to endorse or reject them.

Vitality of Forest Pathology

I can think of no other scientific profession where the need for reminding the membership that one does not correct their ills by treating symptoms should be less than in forest pathology. We need to establish "cause and effect relationships," identify the causes of unacceptable effects, and direct treatments toward modifying or eliminating those causes. There is a growing consensus that the vitality of the forest pathology profession is declining, that this condition is unacceptable to the membership, and that society is not well served by this condition. But, what has the membership done to convince other segments of society of the realities of this situation with forest

Ed F. Wicker is an Assistant Director for Research South at the Rocky Mountain Experiment Station, USDA Forest Service, Fort Collins, CO.

pathology? It is not unique among the sciences. What can we do as a single profession?

Concerns developed and supported through consensus are usually relegated to committees for action. I recall the classic definition of a committee attributed to William Randolph Hearst, "A committee is a group of the unwilling, selected by the unfit, to do the unnecessary." You can not maintain a successful business through management by consensus. Decision making by voting is a born loser. The profession does not need "more of the same."

An approach - The profession needs to reach understanding, acceptance, and support (UAS) and develop a unified position within its membership with respect to the most significant causes of its decline and commit sufficient time, energies, and resources to successfully treat those causes. Until this is done, I see much of the membership remaining perplexed and confused with the situation, continuing to complain about the symptoms of decline, and becoming more disenchanted with the profession. A good example is to be found in a companion art, i.e., the forestry profession. The future of our profession is indeed questionable if we members continue to sit around and "spit at the stove."

Once the causes of decline are established, we need to first look at what the profession is doing that promotes these causes and implement internal changes to correct them. The profession can do this alone. Second, we need to examine those professional responsibilities, roles, and activities that historically and traditionally society has bestowed upon the profession. Any abdication of these need to be reclaimed. The profession will need to reach out beyond its membership to correct this situation. The third issue we need to address is external pressures such as political concerns, economic climates, funding yo-yo's, regulation through federal and civil law, reactive management, etc. The profession has far less control and influence over the issue of external pressures than they do the first two. We need all the help we can get from other scientific professions and our clientele to address this issue.

Mission, Purposes, and Goals

The current situation of decline in the profession of Forest Pathology is not unique but transcends all biological sciences. Unfortunately, the mission and purpose of Federal, State, and private scientific research organizations and institutions, initially established to provide responsive and quality service for the betterment of mankind by achieving and supporting a high degree of excellence in science, have drastically changed. Their missions (at least those organizations that have a mission) are now directed and orchestrated to address political concerns and achieve urgent, short-term, partisan goals through appeasement and crisis management. Such missions are usually vague, ambiguous, or "motherhood" statements and completely void of risk. To clearly and concisely state the mission in print commits management and restricts its flexibility to vacillate and escape accountability. At this stage of evolution, one is witness to the birth of a true bureaucracy whose priority goal is to establish, implement, and perfect processes as a means to an end. Bureaucracies and bureaucrats do not promote competition, but rather they propagate and support the status quo. Their motto is "don't rock the boat"; they breed mediocrity, and it is their destiny.

Science Leadership

Career employees who have acquired national and international recognition for their dedication to excellence of scientific achievement in their chosen fields of science are no longer attracted to positions of leadership in the management of an organization or institution once it achieves the status of a bureaucracy. Their lifetime goals of dedication and commitment to achieving a status of excellence in science are incompatible with the short term, partisan, politically driven goals of the bureaucracy. Leadership roles in the bureaucracy do not meet the needs of the scientist because the scientist's needs do not serve to sustain the bureaucracy. The two agendas are strikingly different. This is most unfortunate because these are the employees accepted and recognized by the global scientific community as eminently qualified and most capable of providing the leadership so vital to the advancement of science through research. The consequences of this reality are equally unfortunate. Those employees who are unsuccessful at achieving eminence as a scientist in their chosen profession, who aspire to achieve status through recognition by and affiliation with some "peer" group, who have visions of occupying positions of authority, who need to feel important, and who possess average or above average tendencies to assign values in reference to personal and material gains are courted by the bureaucracy to occupy leadership roles and fill perceived "power vacuums." Employees who succumb to this career diversion must commit to support the bureaucracy if they are to succeed, and everyone wants to be successful. The employees are trained and molded by bureaucratic mentors to behave and think like bureaucrats so they can better serve an establishment committed to maintaining the status quo. This is a period of imprinting and transformation from a scientist to a bureaucrat. Those who are not amenable to transformation are exiled to positions of little influence and, where possible, at some obscure location with the hope that they will seek employment elsewhere. Successful transformation is achieved when the employee is imprinted with the bureaucracy concepts of management. These include such perceptions as:

- It is better to follow regulations than to exercise one's judgement.
- Facts will only confuse you. Rely on your opinion when making decisions.
- Always agree with the boss. Learn to say yes your honor, yes your majesty, yes, yes, yes.
- You are not to think; you are not to reason why. Good employees do as they are told.
- Diligence is preferred over intelligence.
- Image is more important than reality.
- Loyalty is more valued than productivity.
- Being honest is not being tactful or diplomatic.
- Achievement is only possible by following the bureaucratic process. Line up your ducks, go through all the hoops, close all loops, and success is certain.

- o Delegate all tasks that may tarnish your image.
- o Address trivia with utmost urgency and expediency.
- o Honor and preserve tradition by resisting change.
- o If it isn't broken, fix it anyway.
- o Resolve critical issues through selective neglect.
- o Manage by consensus. Vote on decisions.
- o Delay action and avoid conflict by delegating priority problems to committees. Once managers have mastered this level of mental prowess, they qualify as bonafide bureaucrats -- living, programable robots.

Some employees do not realize that one cannot buy recognition, reputation, trust, creditability, or respect. Such attributes of character must be earned. Once employees achieve the status of a bureaucrat, they are promoted with little or no competition to positions of greater responsibility within the organization. The criteria for promotion and advancement do not include technical competence in science. Results of a recent survey suggests they are mainly social reasons. Such a process of providing leadership for science only breeds mediocrity. Idea generation, creativity, and innovation so vital to progress of science are suppressed by bureaucrats committed to maintaining the status quo.

Clientele Support

It is fact that the major source for financing forest pathology research in this country is Federal funding. This is true for biological sciences research as a whole. For the past 15 years, politicians, special interest groups, and other segments of society have focused on the deficit of Federal spending. The American people have expended considerable time, energy, and finances seeking ways to reduce the national debt. Thus, the pressures for reducing federally funded research for all sciences as a contribution to reduction of the national debt continue to increase. As a consequence, much federally funded research is experiencing the "pains of survival" associated with budget reductions. When budget cuts become eminent, we usually call upon our friends in Congress, the users of our products, and our cooperators (collectively our clientele) for support in getting the funds restored. We use the same process when attempting to obtain budget increases for research program expansion. The level of support we can rightfully expect from our clientele is directly commensurate with how well we have informed them of who we are, what we do, what we can do for them, and why they need us. Apply this test to the current situation in forest pathology. I don't think we score very highly. When was the last time that you, as a research forest pathologist, met with a segment of the public, some user group, or member of Congress and discussed the profession of forest pathology for the purpose of enhancing our visibility? I happen to believe that the persons best qualified to represent the profession are its members. I further believe that the present dilemma of the profession is sufficient testimony for concluding that members have not been very successful in this task. I do not think many people know who we are, much less what we do. Why?

Do we members view these activities with a degree of complacency and then panic when the "axe falls"? Isn't it customary for us to relegate these activities to lower priority for someone else to do? Isn't it true that we expect and depend upon our employers to attend to these activities? I perceive the answers to these questions to be "yes" in most cases and to be a major source of our problem. We have a visibility deficiency that represents an image impairment and a threat to survival of the profession. The members of the profession need to seriously consider measures to reverse this situation or accept the dinosaur destiny. Someone else isn't going to serve as our caretaker. This is a highly competitive world in which we live.

Marketing the Profession

Many scientists active in forest pathology research appear naive or even oblivious of the fact that products are generated as a result of their endeavors. Knowledge is a product of the profession. That knowledge must be advertised and marketed in competition with knowledge generated by other professions. This is little different from any other seller-buyer relationship. The research process, by which the knowledge is generated, is not complete until that knowledge is put to some use towards the perceived betterment of mankind. How many forest pathologists subscribe to this philosophy?

In my previous address, I discussed the need for forest pathologists to "get together" and sell the products within the profession. The marketing cannot stop here, however, which was also discussed in that address. The profession must expand its marketing efforts to include the enormous body of consumers outside the profession in order to remain competitive and survive. Marketing of knowledge products is governed by the same laws of supply and demand as are more tangible products. These laws will dictate the scope of the marketplace. The forest pathology profession must use the whole deck if it is to achieve its potential.

Members of the profession need to become more actively involved in the marketing process by elevating marketing activities to a higher priority task. This will require a personal commitment to prepare oneself to do these tasks efficiently and effectively. It will also require a commitment of a greater proportion of the available resources to marketing than has been allocated in the past. The payoffs will justify these commitments.

Marketing of the products of research begins with identification of the research to be conducted. It is at this stage of the research process that the clientele needs to be identified and invited to participate and become involved in the process. I call this marketing insurance. These activities will serve as a marketing analysis of products that can only be generated by research and that are perceived as needed in the consumer marketplace. Involvement of potential consumers is an excellent mechanism of gaining their support and commitment for the research. Also, the probability of successfully marketing the products, once they are available, is increased significantly.

Research Environment

Forest Pathology is more than a profession. It is a business and that business is science. "Science is not technology, it is not gadgetry, it is not some mysterious cult, it is not a great mechanical monster" (Warren Weaver, President AAAS, 1960). Science is a body of knowledge that encompasses facts, truths, and principles systematically arranged to represent the general laws,

reasonableness, and order of the functioning universe. Scientists are individuals who have achieved a high proficiency and wide recognition in the conduct of science through training and experience. They are people; they did not arrive on earth from outer space. They have feelings and respond to all the range of emotions, frustrations, ambitions, visions, beliefs, compulsions, and intuitions of the normal population. They have the same need for the basic necessities for life and desire the same conveniences. Many scientists have spouses who also aspire to achieving affluence; to own a nice home, or new car; and to acquire social status. This is no different from the aspirations of spouses of doctors, lawyers, politicians, merchants, judges, or thieves. They have children, love those children, and are committed to providing for their livelihood and education just like other folks. They have beliefs and one belief is that they have equal rights to compete for rewards from society commensurate with the services and products they provide society through their labors. They measure success by how it is achieved not in monetary quantities.

The quantity and quality of products and services that scientists provide society is directly related to the quality of the research environment where they live and work. A critical element of the research environment is freedom. Excessive control through rules and regulations and insistence on conformity will stifle innovation, creativity, originality, curiosity, spontaneity, and idea generation -- all essential to the advancement of science. Ideas are not generated upon command and creativity is not a product of conformity. This brings to mind the U.S. Department of Agriculture's current research information system (CRIS) reports where the scientist is asked to identify "planned breakthroughs." Scientists are trained to continually challenge the rules of nature and man made rules are basically illogical without questioning.

The research environment created by many Civil Service organizations conducting scientific research is one in which the best scientists are reluctant to operate. The prestige and sense of responsibility is not there, having been replaced with permissiveness and appeasement. Most employees working in such environments are more interested in getting ahead than in quality and quantity production because they are not rewarded on production merits. They are unwilling or afraid to act, accept responsibility, or take a risk; all are symptoms of self-satisfaction with the status quo. Don't rock the boat so long as you get your share of benefits. Why worry about the future when there is nothing you can do about it. Such a research environment is viewed as an obstacle by those scientists striving to achieve excellence in science because it breeds apathy and mediocrity and does not fulfill their needs.

Consequences

The consequences of our present dilemma in forest pathology and their impacts upon the profession are rather obvious to some of us. In fact, the dilemma is now being recognized by some members as a true crisis. It is most unfortunate that "things gone wrong" in the profession must achieve this status before the membership is motivated to fix them. Perhaps it is because we have lots of experience at managing crises, feel more comfortable doing so, and find it easy to procrastinate. One would think that some simple, timely monitoring of change in the profession would alert its members to potential ills that could be prevented. I assure you, it would be a lot less painful than the therapy necessary to treat a crisis. There is an abundance of documented evidence that the health and welfare of our profession has been failing for

more than 20 years. We have experienced crippling reductions in numbers of scientists, critical reductions in research funding, damaging losses in clientele support, reduced demand for our products and services, sacrifices in quality of professional skills, and a loss of effective leadership in science. Our visibility is extremely low, our image tarnished, and our creditability is questioned. This is very painful for a time honored profession to accept, but from where I sit it is real. It is not too late to treat our ills and correct our wrongs, but time is running out. We are rapidly approaching the crossroads. Which path do we choose?

Responsibility

The responsibility for ensuring progress and directing the destiny of the profession rests with trained, dedicated scientists who comprise the membership. A few individuals did not cause the present dilemma, and a few individuals will not be successful in treating the situation. The profession must accept responsibility for many of its present ills because it has permitted them to develop without timely and prescribed attention and treatment. The time is past when the profession can afford to procrastinate until a crisis is at hand and then resort to the political support of "friends" in Congress for a "quick fix" to make it well and ensure its existence. Such "quick fixes" usually represent "misapplied fixes" and carry an enormous price tag. The overuse of this activity in the past, as a substitute for long range, strategic planning of science, contributes significantly to the present situation of the profession. Besides, political power in Congress for support of science no longer resides in a few influential elected officials.

Forest pathology is not alone in this respect. Look at any number of the other biological and physical sciences serving Federal, State, and private organizations, i.e., NSF, NASA, NIH, Forest Service research, universities, private research laboratories, etc., and one finds some striking similarities. Members of the scientific professions are not providing the strong disciplinary leadership needed to guide the professions in their destiny. As a consequence, they have inadvertently lost control of the profession to those of lesser competence.

What Can Members Do?

A lot! The membership needs to:

- o Regain control of the profession's destiny. We must reclaim the "deed to the ranch." How do we achieve this? Internally through personal commitment and involvement, safeguarding our standards of excellence, and speaking out on issues that have real or potential negative impacts on the vitality of the profession. Now is not the time for complacency; now is the time to act, to stand and be counted. Remember, what you permit, you promote.
- o Decide what they want to happen with the profession, establish a clear and concise mission for the profession, and develop a strategic plan to make it happen. To do this is to ensure a future. The mission must be attainable; it must be so flexible to accommodate change, and it must embrace the wisdom for maximizing benefits the profession can provide society in the future. To do this is to give purpose to life.

- Supply the initiative and conscientiously pursue the roles of leadership appropriate for the profession in science, in society, and in the workplace of employer organizations. We need to actively express our discontent with the status quo, controlled advancement, apathy, mediocrity, permissiveness, appeasement management, and employer pressures to conform to organizational rules that are biased, misapplied, and unnecessary. Research managers need to recognize the synergism between nonconformity and creativity. We should demand of employers the opportunity to actively participate in decision-making and policy-setting activities. We should strongly support consideration of merit based on scientific achievement and technical competency as the top priority selection criteria for filling positions in research management. Some recent polls show that a majority of Americans share this belief. Through active participation, we can influence the quality of research management and the research environment.
- Strengthen clientele support for the profession. We, the members need to broaden our horizons when identifying our clientele beyond the profession. We are the best qualified to tell the story of who we are and what we do. This will require personal commitment, restructuring of priorities, and perhaps some training. All members need to become an "ambassador" for the profession.
- Actively and continuously market the profession. All members can participate by planning a conscientious effort to advertise, support, and sell the products and services generated by the profession. This effort must be active, continuous, and relentless to be competitive with other professions in the marketplace. Remember, knowledge is power and is one of our major products. So long as there are human beings, there will be a demand for power, and we can supply the fuel.
- Initiate and institute changes in the research environment that will create an atmosphere of maximum freedoms and minimum controls. Relevance and productivity of science will flourish in an atmosphere of freedoms. Creativity, originality, spontaneity, and curiosity—the essence of science—are "choked" by controls. This is perhaps the greatest injustice rendered science by a bureaucracy. I recall a recent newspaper headline that read, "Medical research hurt by red tape, panel says." The article reported on the findings from a study conducted by the Institute of Medicine. The study was prompted by a recommendation from the Office of Management and Budget (OMB) that National Institute of Health (NIH) research be taken from the government and turned over to private companies. A conclusion of the report was that "NIH will slip from a world-class player to an also-ran in biomedical research unless its leaders are given more freedom from the federal bureaucracy." Is NIH unique as a research organization in this respect? Isn't forest pathology and most other sciences suffering from the same cause and effect relationship? In the late 1970's, Canada began to privatize some natural resources research and the first 10 years have proven very successful. Similar change is being initiated in New Zealand. Many scientists share the perception that both these countries have surpassed the United States in excellence of natural resources research. Perhaps, we forest pathologists should be so bold to suggest and support such change.

Conclusions

There are clear signals that the vitality of the forest pathology profession has declined over the past 20 years to a critical level. Members are becoming disillusioned with the profession. They are expressing a lack of confidence in the future and a concern for the profession's survival. I view this as normal and the initial phase of problem recognition. Some members find solace in recalling the "good old days" and concluding that the future isn't what it used to be. If the members remain docile and accept this level of initiative as self satisfying, then the profession's future is in jeopardy. On the other hand, if the members are willing to act, accept responsibility, speak out, take risks, and reclaim the initiative to control their destiny, they can ensure a future. That future lies in deciding what we want to happen and then making it happen! We need to express our dissatisfaction with status quo and regulated advancement of the profession, as well as science in general, because we are losing the war of attrition.

Earlier in this address, I presented an approach for addressing this issue of declining vitality. I am sure there are other approaches that would be equally or more effective. The point I wish to make is that time is running out. The membership needs to decide on a course of action and implement it with commitment.

I have discussed with you my perceptions of five aspects of the profession that I believe to be significant and need the attention and commitment of the membership if we are to restore the vitality of the profession to a competitive level. There are several others that I didn't address that may be or may soon become equally or more important. Those are (1) organizational hiring practices, (2) standards of professional competence, ethics, and conduct, (3) science management, and (4) resistance to change. Some of these are highly sensitive societal issues. Nonetheless, they are or have the potential to cause negative impacts on the vitality of the profession and, therefore, must be dealt with. There is no one best way to deal with these concerns. It is not a simple task and there are no panaceas. Only through sincere dedication, commitment, and hard work by the membership will we be successful. If we don't assume the initiative to control our destiny and willingly accept the responsibilities bestowed upon us by society, there are others who are far less competent waiting to do so, i.e., politicians, bureaucrats, judges, lawyers, special interest groups, etc. I am not convinced that forest pathologists are in control of addressing the issue of forest decline in this country or in Europe. That's the way I see it, but I could be wrong.

I wish to thank you for the invitation to share my perceptions on "Public Involvement in Forest Health -- Who Will Speak" with you today. I maintained constant eye contact with the audience and not once did I detect someone asleep. Thus, I conclude that I did present some things of interest to you, and I know that some of it is controversial. I would like to thank you for your attentiveness and willingness to openly share some common concerns affecting our profession. You are a good audience.

ANNOSUS ROOT DISEASE IN WESTERN HEMLOCK 20 YEARS AFTER
TREATING STUMPS WITH BORAX DURING PRECOMMERCIAL THINNING

David C. Shaw, Robert L. Edmonds, Charles H. Driver, Kenelm
W. Russell and Willis R. Littke

ABSTRACT: Percent occurrence and volume impacts of Annosus root disease in coastal western hemlock were documented in 0.1 acre plots precommercially thinned 20 years ago. Two plots were thinned and had borax applied to thinning stumps, two plots were thinned and the stumps left untreated, and two plots were not thinned. Average infection levels of Annosus not associated with wounds were 11.1% for thinned untreated, 4.4% for the thinned with borax treatment, and 4.3% for unthinned. Volume impacts for all treatments were less than 1% (advanced and incipient decay).

INTRODUCTION

Annosus root disease (Heterobasidion annosum (Fr.) Bref. = Fomes annosus (Fr.) Karst) causes root and butt rot in mature (Englerth 1942) and young-growth (Wallis and Morrison 1975) western hemlock (Tsuga heterophylla (Raf.) Sarg.) in western Oregon, Washington, British Columbia and Alaska. Forest management, particularly thinning, has increased the prevalence of this fungus in Europe (Risbeth 1950) and in the southeastern United States (Driver and Ginns 1969). Western hemlock thinning stumps are infected via spores and the fungus moves to the remaining trees via root grafts or contacts (Chavez et al. 1980). Wound infection is also common.

Western hemlock is an intensively managed species in the Pacific Northwest and it is suspected that thinning, particularly precommercial thinning, will increase the within stand spread of H. annosum. Precommercial thinning is now a standard procedure in coastal western hemlock management. Stump infection is generally over 50% in the west (Driver and Wood 1968, Edmonds 1968, Russell et al.

DAVID C. SHAW is graduate research assistant, ROBERT L. EDMONDS is professor, CHARLES H. DRIVER is professor emeritus, College of Forest Resources, University of Washington, Seattle, KENELM W. RUSSELL is Forest Pathologist, Department of Natural Resources, State of Washington, WILLIS R. LITCKE is Forest Pathologist, Weyerhaeuser Corp., Centralia, Washington.

1973, Morrison and Johnson 1978) and can occur in all months of the year (Reynolds and Wallis 1966, Morrison and Johnson 1970). The application of borax to stumps at the time of thinning has been shown to be effective in preventing infection (Russell et al. 1973).

The objectives of this study were to determine (1) volume loss to Annosus root disease 20 years after precommercial thinning and (2) the effectiveness of borax stump treatment.

MATERIALS AND METHODS

The study site is located 2.5 miles southwest of Clallam Bay, Olympic Peninsula, Washington on Washington State Department of Natural Resources land and has been described by Chavez et al. (1980) and Edmonds (1968). A series of 0.1 acre plots were precommercially thinned in 1967 when the trees were 15 years old. Several plots had stumps treated with borax while others were left untreated. In addition, some areas were left unthinned.

We sampled two 0.1 acre plots of each treatment; thinned no borax, thinned with borax, and unthinned. Twenty-three to 35 trees were sampled per plot, and examined for advanced and incipient Annosus caused decay at ground level. Positive identification of *H. annosum* was made using the methods of Chavez et al. (1980) in the first set of plots. The methods of Goheen et al. (1980) were used for our second set of plots.

RESULTS

Total percent of western hemlock trees at Clallam Bay with butt and basal decay is shown in Figure 1. "Other" in this figure refers to infections related to wounds. The thinned with no borax had the highest average percent occurrence of Annosus, not associated with wounds, at 11.1% with a range of 4.3 to 16.1%. The thinned with borax had the second highest average percent occurrence at 4.4% with a range of 0 to 8.7%. The unthinned had the lowest level of average infection at 4.3% with a range of 2.9 to 5.7%.

The percent of total cubic foot volume to a 4 inch top in decay not associated with wounding, both incipient and advanced, is shown in Figure 2. None of the treatments had impacts greater than one percent of the volume. The largest volume impact occurred on a borax treated plot where one codominant tree had a eleven foot high decay column.

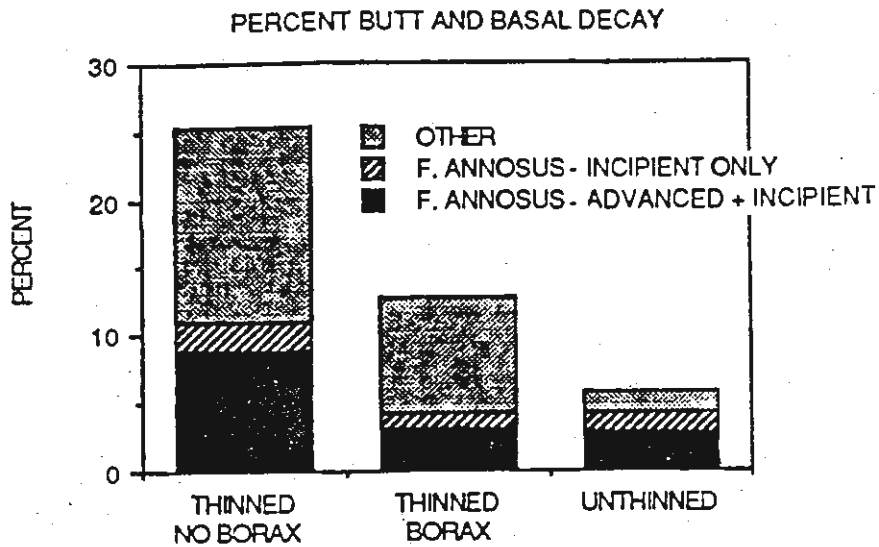


Figure 1. Percent of western hemlock trees at Clallam Bay, WA. with butt and basal decay in precommercially thinned- no borax, precommercially thinned- with borax treated stumps, and unthinned. "Other" refers to infections associated with wounds (mostly *Armillaria* sp.)

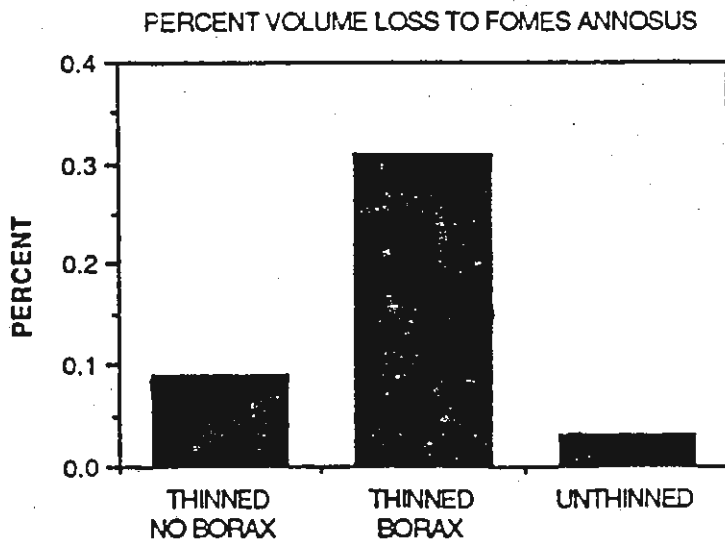


Figure 2. Percent volume loss to *H. annosum* in precommercially thinned- no borax, precommercially thinned- with borax treated stumps and unthinned western hemlock at Clallam Bay, WA.

DISCUSSION

The borax treatment appears to have been effective in reducing occurrence of Annosus root disease to levels similar to the unthinned treatment. Any entrance into the stand may increase Annosus infection.

Volume losses from Annosus are minimal at this time (<1%). The largest losses were on a borax plot which was overwhelmingly the result of one codominant tree with a large decay column.

LITERATURE CITED

- Chavez, T.D. Jr., R.L. Edmonds, and C.H. Driver. 1980. Young-growth western hemlock stand infection by Heterobasidion annosum 11 years after precommercial thinning. *Can. J. For. Res.* 10:389-394.
- Driver, C.H. and J.H. Ginns, Jr. 1969. Ecology of slash pine stumps: fungal colonization and infection by Fomes annosus. *For. Sci.* 15:1-10.
- Driver, C.H. and R.E. Wood. 1968. Occurrence of Fomes annosus in intensively managed young-growth western hemlock stands. *Plant Dis. Rep.* 52:370-372.
- Edmonds, R.L. 1968. Natural occurrence and control of Fomes annosus in precommercially thinned stands of western hemlock. Masters Thesis, Univ. Washington, Seattle.
- Englerth, G.H. 1942. Decay of western hemlock in western Oregon and Washington. Yale Univ., School of Forestry. Bull. No. 50.
- Goheen, D.J., G.M. Filip, C.L. Schmitt, T.F. Gregg. 1980. Losses from decay in 40- to 120- year old Oregon and Washington western hemlock stands. USDA For. Ser., PNW Region, R6-FPM-045-1980.
- Morrison, D.J. and A.L.S. Johnson. 1970. Seasonal variations of stump infection by Fomes annosus in coastal British Columbia. *For. Chron.* 46:200-202.
- _____ 1978. Stump colonization and spread of Fomes annosus 5 years after thinning. *Can. J. For. Res.* 8:177-180.
- Reynolds, G. and G.W. Wallis. 1966. Seasonal variation in spore deposition of Fomes annosus in coastal forests of British Columbia. Dept. For. Can. Bi-Mon. Res. Notes 22:6-7.

Rishbeth, J. 1950. Observations on the biology of Fomes annosus with particular reference to East Anglian pine plantations. I. The outbreaks of disease and ecological status of the fungus. Ann. Bot. 14:365-385.

Russell, K.W., J.H. Thompson, J.L. Steward, and C.H. Driver. 1973. Evaluation of chemicals to control infection of stumps by Fomes annosus in precommercially thinned western hemlock stands. DNR Rep. 33. Dept. Nat. Resour., State Wash., Olympia.

Wallis, G.W. and D.J. Morrison. 1975. Root rot and stem decay following commercial thinning in western hemlock and guidelines for reducing losses. For. Chron. 51:203-207.

ACKNOWLEDGEMENTS: We thank the Washington Forest Protection Association for funding this project and Mr. James Arthurs of the Washington Department of Natural Resources for aiding in all the field work.

THE DEVELOPMENT OF A RISK RATING SYSTEM
FOR COMANDRA RUST IN LODGEPOLE PINE

Jane E. Boyd and William R. Jacobi*

ABSTRACT: Historical weather data were analyzed to determine how many potential basidiospore infection episodes occurred each year at three study areas in Wyoming and Montana. Results indicate that weather episodes that may allow for the infection of pine occurred up to 75% of the years examined. The relationship between infection episodes and canker ages was examined. Because there were relatively constant numbers of new cankers and potential infection episodes occurring in the years examined, no correlations existed between the number of infection episodes and canker numbers. A survey was carried out on the Medicine Bow National Forest, Wyoming to record the severity and location of rust in lodgepole pine and the location and density of comandra plants. Disease incidence in the Medicine Bow is greatly influenced by the distance of the pines from the alternate host. Risk rating of stands can be accomplished by a distance relationship between lodgepole pine and the alternate host. Pines in a high hazard area have a fairly high probability of being infected during a rotation because infection episodes appear likely to occur.

INTRODUCTION

Comandra blister rust is a damaging canker disease of hard pines caused by the fungus Cronartium comandrae Pk. (Brown, 1977; Krebill, 1968). The life cycle of this fungus involves the infection of both pines and the herbaceous comandra plant (Comandra umbellata (L.) Nutt.). Western pines affected by this rust are primarily lodgepole (Pinus contorta Dougl.) and ponderosa (P. ponderosa Laws.). Comandra rust is distributed across North America and is most prevalent in the western United States, particularly in the Rocky Mountains and Intermountain regions. The rust causes widespread damage to lodgepole pine in Idaho, Utah, and Wyoming (Mielke, 1957; U.S. Forest Serv., 1956).

MATERIALS AND METHODS

Weather Data Analysis

Weather data from 1948 to 1987 were analyzed to determine how many potential basidiospore infection episodes occur each year at three study areas. Data were obtained from the National Oceanic and Atmospheric Administration (NOAA), the U.S. Forest Service Fire Weather Data Library (USFSFW), and the Wyoming Water Research Center. Data for the Laramie District, Medicine Bow National Forest, Wyoming included Foxpark NOAA, Foxpark USFSFW, Centennial NOAA, and Centennial WWRC. The Wind River District, Shoshone N.F., Wyoming study area utilized Dubois NOAA, Dubois USFSFW, Burris NOAA, and Lander NOAA. The Dillon District, Beaverhead N.F., Montana study area used data from Dillon Airport NOAA, and Wise River USFSFW. The following criteria were used in selecting potential infection episodes: 1) July- September data; 2) daily minimum/maximum temperature range of 10 - 25°C; and 3) high humidity or a large drop in diurnal temperature range with

*JANE E. BOYD is a Graduate Student and WILLIAM R. JACOBI is an Associate Professor in the Department of Plant Pathology and Weed Science, Colorado State University, Fort Collins, CO 80523.

precipitation. The months of July, August, and September were selected because those are the months when basidiospores are being formed and released. Daily temperature range of 10 - 25°C was selected because Krebill (1968) showed that this was the temperature range at which pine infection occurred. Krebill also showed that greater than 98% relative humidity is necessary for basidiospore germination and survival. Since NOAA data did not contain humidity information, a large drop in the diurnal temperature range relative to surrounding days was used as an indicator of high humidity. Cloud cover reduces heat loss and high humidity stores heat and keeps night time temperatures warm thus reducing diurnal temperature range. Days with an occurrence of precipitation were selected because on days when the relative humidity stays near 100%, precipitation is expected to occur. Episodes selected using all other criteria were classified as weak, moderate, or strong based on their duration and diurnal ranges. Weak episodes were days with a 15-20°F diurnal range and 6-12 hours of high humidity. Moderate episodes were those with diurnal ranges <15°F and 16-24 hours of high humidity. Strong episodes were those in which the diurnal range remained <15°F for two or more days in a row resulting in more than 24 hours of high humidity.

The criteria used in selecting potential infection episodes were validated by comparing dates selected using the criteria with dates selected using hourly humidity data. Dillon, Montana Airport NOAA data were compared with Dillon Airport humidity data and Centennial, Wyoming NOAA data were compared with humidity data from Centennial WWRC.

Once potential infection episodes were identified, they were analyzed against canker ages obtained from previous studies on the Medicine Bow and Shoshone National Forests (Zentz, 1987; Geils, 1982). Canker ages were determined by cutting rust infected trees and examining the growth rings. The year the tree was cankered was recorded as the year cambium was killed. Years were subtracted from the year cankered in an attempt to estimate the actual year of infection. The relationship between cankers and episodes was examined at year cankered minus five years and year cankered minus ten years. Geils (1984) reported that branch infections take one to ten years to reach the main stem depending on how far away from the stem the infection occurs.

Medicine Bow Disease Survey

The study area was located on the Laramie District of the Medicine Bow National Forest near Foxpark, Wyoming. The area was sampled for rust incidence in lodgepole pine and the location and density of comandra plants to determine if disease incidence in pines is related to the distance from the alternate host. The area was 8.1 km by 33.6 km and was sampled according to a system consisting of 2.56 km² blocks subdivided into .16 km² blocks. The sample transects followed an east-west direction.

The disease incidence in the pine was analyzed against the following stand and site parameters: 1) average diameter at breast height (1.3m); 2) average age; 3) average tree height; 4) density; and 5) basal area. Site characteristics including slope, aspect, topography and configuration were also analyzed. Pearson's correlation was used to determine if any relationship existed between all of the above parameters and disease incidence. The relationship between the disease incidence and the distance of the pine from the alternate host was analyzed using Pearson's correlation and multiple regression.

RESULTS AND DISCUSSION

The total number of episodes that occurred during the 40 year study period ranged from 43 to 58 on the three study areas (Figure 1). The Shoshone N.F. had the most episodes with 36 weak, 18 moderate, and 4 strong. The Medicine Bow N.F. had the least number of episodes with 29 weak, 11 moderate, and 4 strong.

Results indicate that weak episodes occur at least once a year 63 to 75% of the time over the 40 year study period (Figure 2). Strong episodes were rare, occurring only 8 to 10% of the years examined. No episodes were found in 15 to 30% of the years.

There appears to be no correlation between the number of infection episodes and the number of cankers occurring over five year blocks (Figure 3) in both the Medicine Bow and Shoshone sites. On both forests, the number of episodes and the number of cankers remain fairly constant over the 20 year period from 1950 to 1970.

The number of cankers at the Medicine Bow and Shoshone sites drops off in the period from 1970 to 1980. There are several theories that may explain this decrease. Younger cankers may be less visible resulting in these trees being over-looked during the sampling process. Factors related to forest aging such as changes in amount of susceptible tissue and changes in stand structure and composition may affect the amount of infection.

The survey for comandra plants showed that the alternate host was concentrated on the eastern edge of the Medicine Bow study area. The average density was 2.2 shoots/m² with a standard deviation of 2.6. The average total number of plants in each .16 km² sample block was 1.56 x 10³.

The disease incidence was a maximum of 45% on the eastern edge of the forest

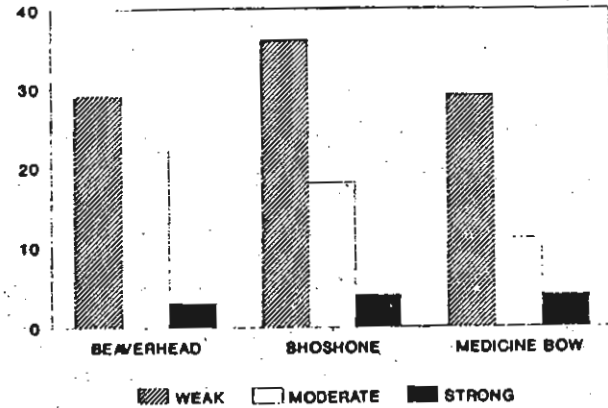


Figure 1--Total number of weak, moderate, and strong episodes that occurred at three National Forests from 1948 to 1987.

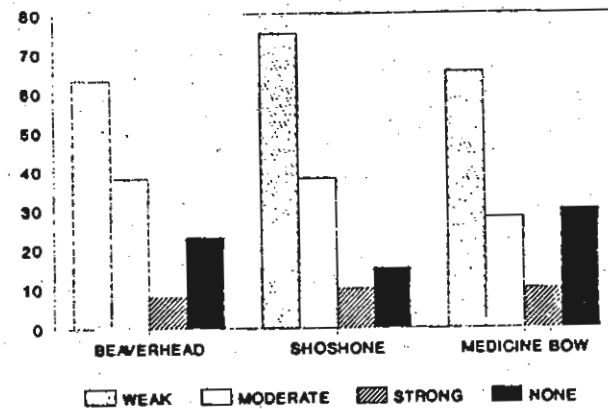


Figure 2--Percentage of the years from 1948 to 1987 in which weak, moderate, strong, or no infection episodes occurred at three study areas.

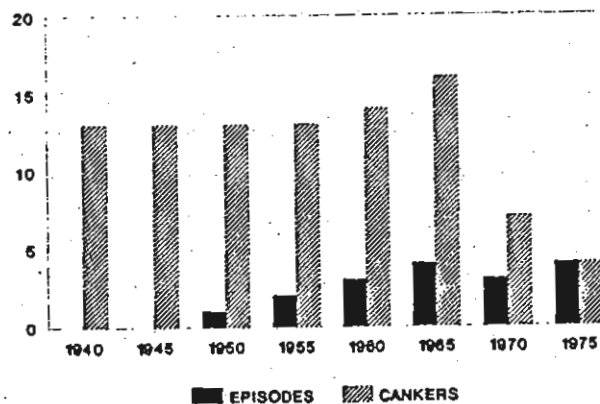


Figure 3--Distribution of comandra rust cankers by age of infection of trees sampled on the Wind River District, Shoshone National Forest and the number of moderate and strong infection episodes that occurred from 1950 to 1980.

and decreased to 0 to 2% at 11.2 km into the forest (Figure 4). There was a high correlation between disease incidence and distance from the concentration of the alternate host with a coefficient of $-.86$ at a significance level of $<.001$. The variation in disease incidence can be explained by the equation, $\text{Disease} = -.03(\text{distance}) + .004(\text{distance}^2) + .574$ with an r^2 of $.84$.

There were no strong correlations between disease incidence and any of the stand and site parameters analyzed. Average DBH, average tree height, topography, and configuration were significantly correlated at the $.05$ level, but the correlations were weak ($.18 - .22$) (Table 1).

These results indicate that a risk rating system for comandra blister rust in lodgepole pine may be accomplished by a relatively simple distance relationship between the pine and comandra plants. Pine stands located in a high hazard area based on the distance from the alternate host have a good probability of being infected during a rotation because several infection episodes are likely to occur.

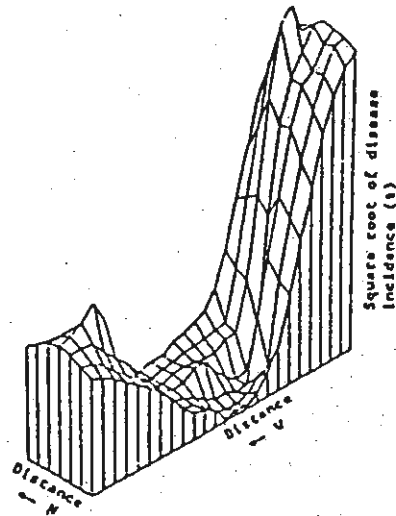


Figure 4--Disease incidence on a 8.1 km by 33.6 km study area on the Laramie District of the Medicine Bow National forest. The X and Y axes denote distance at 1.6 km intervals from forest edge to forest edge.

Table 1--Correlations of stand and site parameters with disease incidence

Parameter	Coeff	Sig
DBH	.18	.04
Age	-.03	.38
Height	.20	.03
Density	-.06	.30
Basal area	.04	.34
Slope	.10	.18
Topography	-.24	.01
Aspect	-.04	.38
Configuration	.22	.02

LITERATURE CITED

- Brown, D. H. 1977. Management guidelines for lodgepole pine stands infected with comandra blister rust and dwarf mistletoe. USDA For. Serv., State Prov. For., Tech. Rep. R2-9. 21pp.
- Geils, B. W. 1984. Comandra blister rust damage and development on lodgepole pine. PhD dissertation, Colorado State University. 72pp.
- Krebill, R. G. 1968. Cronartium comandrae in the Rocky Mountain States. USDA For. Ser. Res. Pap. INT-50. 28pp.
- Mielke, J. L. 1957. The comandra blister rust in lodgepole pine. USDA For. Serv. Res. Note INT-46. Ogden, Utah. 8pp.
- Zentz, W.R. 1987. Comandra blister rust incidence: Effects of host and alternate host location and site characteristics. M.Sc. thesis, Colorado State University. 164pp.

THE EFFECT OF ENVIRONMENTAL STRESS ON CYTOSPORA CANCKER OF ASPEN
John C. Guyon II, William R. Jacobi and Gary A. McIntyre*

ABSTRACT

The effect of selected environmental stresses on Cytospora cancker of Populus tremuloides was examined in greenhouse pot studies. Trees subjected to drought stress had significantly larger canckers than control trees while flooded trees did not. In separate experiments severe (75 + 100%) defoliated trees had significantly larger canckers than control trees. Trees with light (50%) defoliation did not have larger canckers than control trees.

Cytospora chrysosperma (Pers.) Fries (imperfect stage of Valsa sordida Nitschke) has long been known to be an important pathogen of the genus Populus (2). C. chrysosperma is a facultative parasite that attacks trees when their resistance is lowered by environmental stress (1, 7). The specific stresses that are important on aspen (Populus tremuloides Michx.) are not known. Three stresses important in other diseases induced by facultative parasites are drought, flooding and defoliation (6).

If specific stresses important in the relationship between stress, Cytospora and aspen can be elucidated, the information would be useful in forest planning. Specifically, suitability of a particular site for aspen could be determined. Additionally, information on the type and magnitude of stresses could be used to manage urban or nursery environmental conditions to prevent disease.

MATERIALS AND METHODS

Drought and Flooding

Three-year-old, container grown aspen seedlings were grown in five gallon black plastic pots in a soil mix containing 25% sand, 20% peat, 5% composted manure and sawdust and 50% local clay loam. Seedlings were allowed to acclimatize to greenhouse conditions for one month prior to inoculation with C. chrysosperma.

Three stress treatments with eight trees per treatment were used in the two experiments. The first treatment was drought stress achieved by withholding moisture from the trees until they reached -1.5 to -2.0 MPa as monitored with a pressure bomb (6). When the trees reached this critical level the first time they were inoculated. After this whenever trees reached this degree of stress they received a light (250 ml) watering. This process was continued until the conclusion of the experiment.

The second treatment was the control where trees were watered every three days until runoff occurred. The moisture status of these trees never went below -1.0 MPa and was usually maintained between 0.5 and 1.0 MPa. The final treatment was flooding stress achieved by placing trees in a tank of water so the entire soil profile and approximately 5 cm of the stem was submerged. The oxygen status of the soil

*JOHN C. GUYON II is a Graduate Student and WILLIAM R. JACOBI and GARY A. MCINTYRE are an Associate Professor and Professor in the Department of Plant Pathology and Weed Science, Colorado State University, Fort Collins, CO 80523.

surrounding the roots was monitored every three days with an oxygen electrode (Fisher platinum type combination electrode #7320). In addition, moisture status of the leaves was monitored with a pressure bomb. Flooded trees were considered to be at their stress threshold after 24 hours in the tank. After approximately 24 hours stomates close thus reducing photosynthesis and inducing stress (4). Inoculations were made 48 hrs after the trees were placed in the water.

A C. chrysosperma isolate from aspen from Fort Collins, Colorado was grown for seven days prior to inoculation on YM agar (American type culture collection media 200 modified by using maltose as a carbon source (3)). Mycelial blocks approximately 1 cm square were used as inoculum.

Wounds of a mashing-lacerating type were made through the bark to the sapwood with a 2.54 cm cold chisel. The bark and wound area was sterilized with 70% ethanol before and after wounding. The inoculum was placed on these wounds and wrapped with parafilm in an effort to keep the wounds moist and exclude other fungi. There were three wounds per tree located at least 30 cm apart with the bottom wound at least 15 cm above the soil line.

Canker size was monitored at three day intervals until the conclusion of the experiment. Measurements were made in the horizontal and vertical directions wherever the canker was the largest. A percent girdle (% of the tree's circumference killed by the fungus) value was also calculated. Data were subjected to an analysis of variance using SPSSX (9) programs and significance was tested using a one way f test sequential sum of squares at the $P < 0.05$ level.

Defoliation

One-year-old aspen seedlings were grown in one gallon black plastic pots in the same soil mix as the drought and flooding trees. The first of four treatments was the control (no defoliation). The second treatment was 50% defoliation, the third was 75% defoliation and the fourth was 100% total continuous defoliation. Defoliation was achieved by randomly removing leaves at the base of the petiole with a razor blade.

Since a stress period of three to four weeks (6) is required to cause significant defoliation stress, the defoliation regimes were maintained for four weeks prior to inoculation. The inoculations were made the same way as the drought and flooding experiments except only one wound was made per tree and a smaller (1.27 cm) chisel was used. Inoculum was week-old cultures of C. chrysosperma grown on YM agar. The data for the defoliation experiments were analyzed by a one way f test using a Minitab (5) program.

PRELIMINARY RESULTS

Drought and Flooding

Significant trends were noted in the size of cankers (Fig. 1) and the amount of girdling (Fig. 2) that developed in the drought stress treatment. In the drought stress treatment canker size and percent girdle were significantly ($P < 0.05$) larger than the control both

overall (linearly) and at each measurement date. The percent girdle and canker size for the flooding treatment were not significantly different from the control either linearly or at any measurement date.

The difference in canker size and percent girdle were related to the monitoring of stress with a pressure bomb. While a difference between the flooding treatment and the control could be established with the oxygen electrode, this difference was not related to canker size.

Defoliation

Trees with 100% defoliation had significantly larger cankers than control trees at all three measurement dates. Trees with 75% defoliation did not have larger cankers at the first two measurement dates. At the last measurement date, however, the size of the cankers on the 75% defoliated trees was significantly larger than the control. Trees with 50% defoliation did not have significantly larger cankers on any measurement date.

DISCUSSION

The noted trend that drought and defoliation appear to predispose aspen to *Cytospora* canker could have implications in aspen forest planning and management of aspen in nursery and ornamental settings. This research also indicates that under some conditions *Cytospora* canker may be a more serious parasite than was previously thought (3).

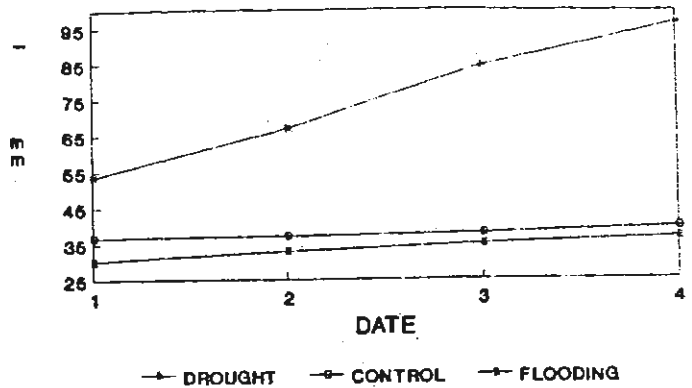


Figure 1. Effect of environment stress on *Cytospora chrysosperma* size on *Populus tremuloides* over 4 measurement dates 3 days apart.

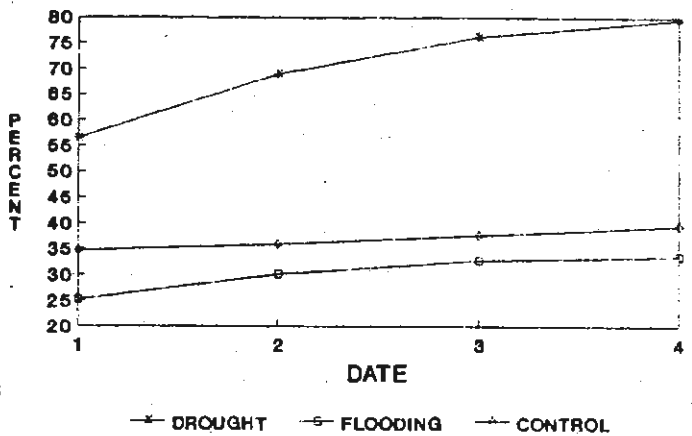


Figure 2. Effect of environmental stress on percent girdling by *Cytospora chrysosperma* on *Populus tremuloides* over 4 measurement dates 3 days apart.

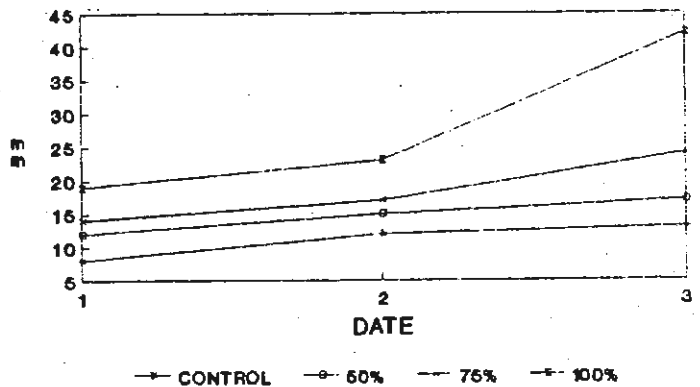


Figure 3. *Cytospora* canker sizes on *Populus tremuloides* over 3 measurement dates 3 days apart in relation to various levels of defoliation.

REFERENCES

1. Biggs, A. R., D. D. Davis and W. Merrill. 1983. Histopathology of cankers on Populus caused by Cytospora chrysosperma. Canadian Journal of Botany 61:563-574.
2. Christensen, C. M. 1940. Studies on the biology of Valsa sordida and Cytospora chrysosperma. Phytopathology 30(6):459-475.
3. Hinds, T. E. 1964. Distribution of aspen cankers in Colorado. Plant Disease Reporter 48(8):610-614.
4. Konicek, D. E. and A. W. Helton. 1962. An optimum environment for the culturing of Cytospora isolates. II. Carbon sources. Mycopathol. et Mycol. Apl. 16:27-34.
5. Kozlowski, T. T. 1984. Plant responses to flooding of soil. Bioscience 34(3):162-167.
6. Minitab, Inc. 1985. Minitab Users' Guide. 488 pp.
7. Schoenweiss, D. F. 1981. The role of environmental stress in diseases of woody plants. Plant Disease 65(4):308-314.
8. Tao, D., P. H. Li, J. V. Carter and M. E. Ostry. 1983. Relationship of environmental stress and Cytospora chrysosperma infection to spring dieback of poplar shoots. Forest Science 30(3):645-651.
9. SPSS, Inc. 1986. SPSSX Users' Guide. 988 pp.

ARMILLARIA IN SOME NEW ZEALAND SECOND ROTATION PINE STANDS

Martin Mac Kenzie and Nicholas M. Self

ABSTRACT: The incidence of *Armillaria* infections of second-rotation stands was assessed in Karioi and Kaingaroa forests. The survey in Karioi forest indicated that, following poison-thinned *Pinus ponderosa* or *P. nigra* crops, sub-lethal infection of the second-rotation *P. radiata* could reach 60-70% by the time the stands were reduced to final crop stocking. Lower levels of sub-lethal infections were found in Kaingaroa forest. A hypothesis for the mode of action of this fungus in these forests is discussed.

INTRODUCTION

In New Zealand the study of *Armillaria* caused root rot of *Pinus radiata* D. Don has concentrated on first-rotation stands established on sites recently cleared of indigenous forest (Shaw and Calderon 1977; Shaw and Toes 1977; MacKenzie and Shaw 1977; Roth *et al.* 1979; van der Pas 1981b; van der Pas and Hood 1985). An early exception is Gilmour (1954), who surveyed the incidence of *Armillaria* in over 40,000 ha of first-rotation pine on sites previously grass or scrub covered. Many of the 53 plots surveyed by Gilmour (1954) were within the area which had suffered from the 1946-1951 epiphytotic caused by the wood wasp *Sirex noctilio* Fabricius and its symbiotic fungus, *Amylostereum areolatum* (Fries) Boidin. Gilmour (1954) examined the root collar of over 2000 spars and dead or dying trees and never found a single example of parasitic attack by *Armillaria*. He concluded that although the fungus was present, it was not parasitically active in 20 to 28 year old, first rotation stands of *Pinus radiata* in Kaingaroa forest.

The situation was to change. The needle-blight fungus, *Dothistroma pini* Hulbary was accidentally introduced in 1962, and first rotation stands of *Pinus nigra* Arn. and *P. ponderosa* Laws, proved to be highly susceptible to it (Kershaw *et al.* 1982). Ten years after the introduction of this fungus, Gilmour ^{1/} was to report the pathogenic activity of *Armillaria* in first rotation stands of *P. ponderosa*. These stands had been thinned between 1963 and 1966 and been severely defoliated by *D. pini* each year, for at least, the previous 5 years. Gilmour ^{1/} speculated that after years of severe defoliation, *Armillaria* was hastening the death of previously dominant trees.

In the process of evaluating a research project on land preparation for sites of once poison-thinned *P. nigra* or *P. ponderosa* crops, some second-rotation stands of *P. radiata* in Karioi forest were surveyed for pathogenic *Armillaria* attack. To contrast this data, second-rotation stands in Kaingaroa forest, where poison thinning had never been used as a silvicultural tool, were also examined. Stands in Kaingaroa forest with a history of *Armillaria* caused mortality were selected and a random transect of 100 trees examined. Infections were assessed as described in the methods section. Two of these stands (1075 and 1078) were 11 year old, second rotation *P. radiata* on the sites of once severely *Dothistroma* defoliated *P. nigra* stands. They had *Armillaria* infection levels of 94 and 67% of the stems respectively. As this preliminary survey contradicted the conclusions of Gilmour (1954) and exceeded the expectations of Gilmour (1972) ^{1/} it was decided to survey a more representative sample of Kaingaroa forest and present the results along with those already obtained from Karioi forest.

^{1/} Forest Service Note 49/0/3/1, Unpublished, by J. W. Gilmour, 5 May 1972, Mortality in *P. ponderosa*, Northern boundary Kaingaroa.

MARTIN MAC KENZIE plant pathologist,
Unemployed, Dumas, Texas.
NICHOLAS M. SELF technician,
Ministry of Forestry, Rotorua, New Zealand.

METHODS

1. Stand Selection In Karioi Forest

The conversion of once poison-thinned stands in Karioi forest has gone on piecemeal since 1971, being largely dependent upon timber markets. Between 1971 and 1981, some 255 ha of first crop had been converted. In any one year, the conversion was usually concentrated in a single compartment. Consequently, a systematic survey was conducted of the major areas of conversion within this time span.

2. Stand Selection In Kaingaroa Forest

The 40,000 ha of first-rotation pine surveyed by Gilmour (1954) included Waimihia forest. In this paper Kingaroa forest will be used *sensu* Gilmour (1954) (i.e. to include Waimihia forest). Harvesting the first crop in Kaingaroa forest has gone on at such a rate as to necessitate the use of stratified random sampling. Second-rotation stands were stratified by the species of the first crop, with five strata being recognized. Stands were classified as being: (1) *ex P. radiata*, (2) *ex P. ponderosa* (3) *ex P. nigra* var *laricio* (Poir.) Maire, (4) *ex Pseudotsuga menziesii* (Mirb.) Franco, and (5) *ex* all other species. From each of these five strata, a random sample of five stands with establishment dates between 1975 and 1979, was surveyed. An attempt was made to relocate and reassess the 1950 plots used in the previous survey of *Armillaria* in Kaingaroa forest (Gilmour 1954).

3. Stand Sampling Method

Offset transects of 200 trees/stand were used. The transects were oriented in the direction of the planting lines, and after sampling 20 consecutive living trees, the transects were offset 5 planting rows. The starting point of each transect was located at random along the stand margin, but far enough in from the edge to avoid the effects of road-making, old firebreaks, skid sites, and/or log decks. When such obstacles were encountered in a transect, they were not sampled. Should a transect reach the edge of a stand, the line was again offset and the second leg continued back through the stand so as to diverge from the first leg.

4. Tree Infection Assessments

Individual trees were assessed for *Armillaria* infections after the soil and litter had been scraped clear from the root collar region. Hatchets, modified to look like miniature Pulaskis, were used for root collar excavations. A tree was considered to be infected if examination revealed the presence of both attached rhizomorphs and basal resinosis. Trees having either attached rhizomorphs or basal resinosis, but not both, were considered to be uninfected. Based upon the presence or absence of rhizomorphs and the extent of basal resinosis, the following five classes of trees were recognized:

- (i) Uninfected (U).
- (ii) Lightly infected (L); rhizomorphs + basal resinosis < 5 cm of basal circumference.
- (iii) Moderately infected (M); rhizomorphs + basal resinosis > 5 cm but < 50% of basal circumference.
- (iv) Heavily infected (H); rhizomorphs + basal resinosis > 50% but < 100% of basal circumference.
- (v) Very heavily infected (VH); rhizomorphs + basal resinosis = 100% of basal circumference.

RESULTS

Stand details and the results of the survey of Karioi forest are given in Table 1; similarly, Table 2 gives the results from Kaingaroa forest.

TABLE 1 - *Armillaria* infection levels in stands of *P. radiata* established at Karioi forest on sites of once poison-thinned *P. nigra* or *P. ponderosa*

Stand	First Crop	Age of 2nd Crop	% Infection	Infection Class			
				L	M	H	VH
12/05	<i>P. ponderosa</i>	14	70	8	33	21	8
12/06	<i>P. ponderosa</i>	13	65	17	34	10	4
27/02	<i>P. ponderosa</i>	12	76	14	36	20	6
11/12	<i>P. ponderosa</i>	11	64	10	27	19	8
5/06	<i>P. ponderosa</i>	10	56	12	33	6	5
5/07	<i>P. ponderosa</i>	9	56	12	29	9	6
8/13	<i>P. ponderosa</i>	8	70	10	31	21	8
23/08	<i>P. nigra</i>	7	56	5	21	16	14
8/14	<i>P. ponderosa</i>	4	22	0	8	6	8

TABLE 2 - *Armillaria* infection levels in second rotation stands in Kaingaroa forest

Stand	First Crop	Age Years	Site Class ¹ /	% Infection	Infection Class			
					L	M	H	VH
267	<i>P. radiata</i>	6	III	10	2	6	1	1
865	<i>P. radiata</i>	7	III	5	1	2	2	0
391	<i>P. radiata</i>	8	II	31	5	16	6	4
155	<i>P. radiata</i>	9	II	38	4	16	12	6
201	<i>P. radiata</i>	10	II	28	6	12	9	1
672	<i>P. ponderosa</i>	6	III	2	0	1	1	0
563	<i>P. ponderosa</i>	7	III	2	0	1	1	0
1023	<i>P. ponderosa</i>	7	III	1	0	1	0	0
667	<i>P. ponderosa</i>	8	III	6	1	2	2	1
668	<i>P. ponderosa</i>	9	III	20	5	10	3	2
615	<i>P. nigra</i>	6	III	3	0	1	2	0
1017	<i>P. nigra</i>	7	II	30	4	14	7	5
616	<i>P. nigra</i>	7	III	18	6	10	2	0
459	<i>P. nigra</i>	8	II/III	34	8	19	5	2
28	<i>P. nigra</i>	10	II	22	4	13	3	2
354	<i>P. menziesii</i>	6	II/III	18	5	2	9	2
1105	<i>P. menziesii</i>	7	II	20	3	9	6	2
1096	<i>P. menziesii</i>	7	II	31	9	11	8	3
350	<i>P. menziesii</i>	8	III	10	4	1	4	1
1095	<i>P. menziesii</i>	9	II	42	7	18	10	7
241	<i>P. contorta</i>	6	III	4	1	3	0	0
275	<i>P. contorta</i>	6	II	0	0	0	0	0
218	<i>P. contorta</i>	7	II	1	0	1	0	0
1054	<i>P. muricata</i>	8	III	1	0	1	0	0
228	<i>P. contorta</i>	9	II	0	0	0	0	0

¹/Site class as per Ure (1950)

Of the 25 permanent plots surveyed by Gilmour (1954), only one remained at the time of this survey (Plot RO.515 in Compartment 1256). Two of the 16 trees remaining in this plot had sub-lethal infections. Dead rhizomorphs and mycelial sheets were found beneath the bark of long-dead trees, in the adjacent to the plot. One plot tree (recorded as moribund by Ranger^{2/} in 1962) was obviously decayed by *Armillaria*. The rot and attached rhizomorphs were judged by the authors to be viable.

DISCUSSION

Observations made during these surveys are compatible with the working hypothesis of *Armillaria* activity in these forests. This hypothesis is not the work of the authors alone, but has been developed over the last 15 years. An outline of this hypothesis first appeared in a 1972 file note by J. W. Gilmour ^{1/}, and since then it has appeared, in one form or other, in numerous Forest Services files. It was briefly described by van der Pas (1981a). The authors have re-formulated this hypothesis with six distinct phases to explain the activity of *Armillaria* over the first two rotations of these forests.

- Phase 1: The saprophytic existence of the fungus in native forest vegetation adjacent to the pine forests.
- Phase 2: The saprophytic colonization of the first rotation thinning stumps. It is hypothesized that basidiospores played a role in spreading the fungus from the native forest into the pine plantations. The thinnings may have been production, biological, or poison.
- Phase 3: The sub-lethal parasitic colonization of the first rotation stems remaining after thinning. It is hypothesized that rhizomorphs originating on the thinning stumps were responsible for the spread of the fungus to the living stems.
- Phase 4: The saprophytic colonization of the first rotation stumps. It is hypothesized that after the harvest of the first rotation, the once small, sub-lethal, parasitic lesions expanded to become extensive saprophytic infestations.
- Phase 5: The lethal parasitic colonization of the second rotation *P. radiata* seedlings. It is hypothesized that using rhizomorphs originating on the first rotation stumps, the fungus moved out to kill the seedlings of the second.
- Phase 6: The development of sub-lethal parasitic lesions on the roots and root collars of the second rotation stems. It has already been shown (Mac Kenzie, 1987) that as *P. radiata* trees age, they become tolerant of *Armillaria* infections. Unsuppressed trees over the age of 9 which are not suffering from severe *Dothistroma pini* infection, have the ability to tolerate, and in some cases recover from *Armillaria* infections (Mac Kenzie, 1987). With the exception that phase 6 is in the second, and not the first rotation, it is similar to phase 3.

The authors found supportive evidence of phases 2 through 5, the sixth being the subject of this report.

Thinning of first rotation stands has taken three forms. In the final analysis, the *Sirex noctilio* induced epiphytotic of 1946-1951 can be viewed as a beneficial biological thinning for it was mainly malformed and suppressed trees which were killed, Gilmour (1961). Timely production thinnings have been one of the reasons that there has not been a subsequent outbreak of this insect. However, production thinning has not always been possible, between 1952 and 1956, ammonium sulfamate and sodium arsenate were used to thin the earlier (circa 1930) plantings of *P. ponderosa* and *P. nigra* at Karioi forest. In many cases, the poison-thinned trees remain as decaying spars. The bark of these spars remains almost unaltered, the sap and much of the heartwood has long been destroyed by fungal and insect activity. Between the bark and decayed sapwood, dead and dried, rhizomorphs plus mycelial sheets could be found. In some cases, the decayed sapwood was penetrated by a network of dead but recognizable rhizomorphs.

^{2/} NZFS. For. Res. Inst., file 28/17/2, Unpublished, by F. J. Ranger, 29 Aug. 1962, *Sirex* mortality plots 1962.

To gather evidence of phase 3 (the establishment of sub-lethal lesions on the root collars of the first rotation stems), the authors excavated the root bases of every tree in a randomly selected, 20x20 m plot in compartment 22 of Karioi forest. All 13 trees were found to have sub-lethal lesions. The smaller trees had the larger lesions. It is local forest knowledge that compartment 22 had been a summer poisoning operation and consequently was successful. The fourth phase (saprophytic colonization of first crop stumps) was observed in uprooted stumps and agrees with the description of Pas (1981a). *Armillaria* killed trees of the second rotation (phase 5) were most obvious in the two youngest stands surveyed (Table 1). The older stands had received at least one thinning and the standing *Armillaria* killed trees been felled. Although *Armillaria* killed trees were encountered in the older stands, they were infrequent.

The classical concept of radially expanding infection centres was discussed by Mac Kenzie and Shaw (1977). Two years later, Roth *et al.* (1979) cautioned that this effect might be more apparent than real. When the available plots were older still, they were reassessed by van der Pas (1981b), who was able to quantify the suspicions of Roth *et al.* (1979). If the observations made in compartment 22 are typical of poison-thinned stands, then it can be seen why the concept of radially expanding infection centres has not been reported from Karioi. Simply, the inoculum sources (first rotation stumps) are all but systematically distributed. As an initial solution to the Karioi problem, the planting density was doubled to 2400 stems/ha. This worked, for the inoculum was uniformly distributed and the fungus could not kill enough trees before they became tolerant of infection. When surveying stands with an infection level of 20% or greater, the authors got the impression of dealing with a single infection centre, or perhaps more accurately, many infection centres which had subsequently coalesced into a single patch within which there were "islands of uninfected trees". That a stand could have coalesced infection centres and an overall infection level of only 20% would indicate that the infections are widely and relatively uniformly distributed throughout the stand.

Mortality curves for *P. radiata* stands established on sites recently cleared of their native vegetation (Mac Kenzie and Shaw 1977; Shaw and Calderon 1977; van der Pas 1981a) show mortality rates of 15-20% per annum for the first 2 years. By the third and fourth years, the rate has dropped to nearer 10% per annum (van der Pas 1981a). By the time stands have been thinned to their prescribed final stocking, mortality rates have fallen to less than 1% per annum (Mac Kenzie, 1977). The reduction in stocking consequent to thinning reduces inter-tree competition and makes it easier for trees to tolerate infection. However, the move to wider spacing increases the individual tree's exposure to the wind, and the risk of windthrow of trees that are otherwise sub-lethally infected (see figure 3 in Shaw and Calderon 1977) is also increased. The reduced rate of mortality reflects an increase in tree tolerance to the fungus and not a decline in its activity. For at Karioi it would seem that infection levels reach 60-70% by the time of final thinning and remain at this level (Table 1).

When the levels of the individual infection classes (light through very heavy) are examined, a trend towards increasing class size with increasing infection level is obvious for all but the lightest infection class. As trees in the light infection class were the most difficult to detect, it is likely that this class has been underestimated. At the other extreme, the very heavily infected trees were easy to detect, many had thin crowns and could easily be rocked in the ground. Uninfected trees bent or swayed when pushed on. A few heavily infected leaning trees were easily pushed over. Obviously heavy infections are going to lead to wind instability in the later life of the crop. Should heavily, *Armillaria* infected trees be windthrown at a rate of as low as 1% per annum, then the cumulative losses in the 10-20 years after final thinning may be more significant than the 40-50% mortality occurring (on the worst sites at Karioi) in the years prior to the first thinning.

Although Karioi forest is not the only forest where poison thinning was practiced, it is the only forest form which an *Armillaria* caused problem has been reported in the second rotation. Obviously the situation is not as simple as the working hypothesis would suggest. It is possible that the environment at Karioi is such that biological control mechanisms operating in the other forest do not function at Karioi. Karioi is one of New Zealand's highest altitude production forests, and it will experience extremes of soil temperature which could reduce the activity of potential antagonists. It is the interpretation of the overall survey of Kaingaroa (Table 2) which provides the greatest difficulties. There are some general observations which can be made and some specific questions which can be asked. As the levels of infection (Table 2) in each stand lack confidence limits, it is not possible to make predictions of infection trends within each of the five classes of second-rotation pine. Compartments 615 and 616 have a common border and were originally planted with *P. nigra* in 1933 using stock derived from the same seed source. Apart from the operations being carried out one year later in compartment 616, both were similarly harvested, their sites cleared, and replanted in *P. radiata*. Does the 15% difference in *Armillaria* infection level between these two compartments reflect the true rate of spread of this disease in one year? Similar questions can be asked of ex Douglas fir in ex *P. ponderosa* sites. The three ex Douglas fir compartments, 1105, 1095, and 1096, are contiguous and have similar histories, yet a 3-year span in starting operations has led to a span of

infection levels from 20% to 42%. The third example of contiguous stands with large differences in infection levels involves the two ex *P. ponderosa* compartments, 667 and 668. Here there is a greater than three-fold difference in infection level, yet the sites have almost identical histories. The rate of spread of this disease needs to be investigated further.

Very little *Armillaria* infection was found in the *P. radiata* stands established after *P. contorta* or *P. muricata* crops. In the case of the ex *P. contorta* sites, the explanation for this low *Armillaria* presence may lie in the nature of the first crop and the means of site preparation for the second crop. The *P. contorta* did not grow well in Kaingaroa; so poor was its growth that on none of the sites surveyed was the "crop" thinned or harvested. Site preparation involved tractor crushing of the *P. contorta* followed by burning. The tractor crushing uprooted many of the trees and the burn destroyed many of the root systems. The destruction of the root systems, combined with the small tree size, made these sites unsuitable for the initial colonization by *Armillaria*. In these compartments, phases 2 and 4 of the proposed hypothesis were not possible.

Although Douglas fir is said to be resistant to *Armillaria* (Peach 1961), or at least show less mortality than *P. radiata* (Gilmour 1961), crops following Douglas fir can be as severely infected as in any other sequence of species (Table 2). Van Boven (1974)^{3/} reported that, following the production thinning of Douglas fir in Kaingaroa forest, the thinning stumps became infested with *Armillaria*. He found that the level of infestation increased to stump age 6 and was maintained at 37% of stumps infested until at least 14 years after thinning. As root grafting was common, many of the stumps remained alive and thus the infestations were best considered as being sub-lethal infections of the remaining trees. This situation can be viewed as being similar to phase 3 of the hypothesis for *Armillaria* in poison-thinned stands at Karioi. Consequently, high levels of *Armillaria* infection of the second crop should be expected on these sites. Of the five ex Douglas fir sites examined, the two with the lowest infection levels had not been production thinned. By noting the floristic composition of the vegetation on adjacent firebreaks and unplanted areas within compartments, Ure (1950) was able to provide an ecologically-based site classification for Kaingaroa forest. Using this classification, Gilmour (1954) stratified his sampled stands into 3 site classes. Although he found *Armillaria* in 45% of his plots, none of the records came from a site class III stand. In a later, unpublished note, Gilmour^{1/} speculated that the residual, natural vegetation in the gullies and unplanted areas of the better (class I and II) sites was acting as a reservoir for the native *Armillaria* species. He further hypothesized that consecutive years of heavy infection of first-rotation *P. ponderosa*, by the needle cast fungus *D. pini* had reduced the stand vigor and hastened the build up of *Armillaria* on these sites. Of the examined compartments established on ex *P. radiata*, ex *P. nigra*, or ex Douglas fir sites (Table 2), the three compartments with the highest *Armillaria* infection level, in each of the 3 strata, are also the best sites. Thus, it would seem that *Armillaria* caused problems in the second rotation correlate better with site class than they do with the susceptibility of the first-rotation species to infection by *D. pini*. As Douglas fir is rarely infected by *D. pini* and *D. radiata* shows a high degree of resistance after age 10 (Kershaw *et al* 1982), it was expected that *Armillaria* infection levels would be highest on sites once occupied by the highly susceptible *P. nigra* and *P. ponderosa*. They were not. The role, if any, that *Dothistroma* plays in the build up of *Armillaria* in these forests has yet to be explained. In the survey reported here (Table 2) pathogenic *Armillaria* was found in 82% of class II sites and 100% of class III sites, whereas Gilmour (1954) found saprophytic *Armillaria* in 52% and 0% of these site classes respectively. Although *Armillaria* was found in all class III sites, it was found 3x more frequently on class II sites. Thus, in the 36 years since Gilmour (1954) conducted his survey, not only has the fungus apparently become pathogenic, but it has moved onto all site classes. Conceivably, if no corrective action is taken, by the time the third and fourth rotations are being planted, the fungus will be evenly distributed throughout the entire forest. The easiest (if not the cheapest) way to break the *Armillaria* disease cycle could be to make stumping of heavily infected sites part of the re-establishment procedure. This would break the cycle at phase 4 of the proposed hypothesis for the action of this fungus.

ACKNOWLEDGEMENTS

The senior author wishes to acknowledge that most of this research was carried out while he was employed by the New Zealand Forest Service.

^{3/} van Boven, R.J., 1974, Unpublished: *Armillaria* in Douglas fir stumps in thinned stands, NZFS. FRI Forest Entomology Internal Report No. 9.

REFERENCES

- Gilmour, J. W. 1954: *Armillaria mellea* (Vahl) Sacc. in New Zealand. Part I: In: Stands of *Pinus radiata* D. Don in Kaingaroa State Forest. For. Res. Notes. For. Res. Inst. NZFS 1: 1-40.
- Gilmour, J.W. 1961: *Armillaria mellea* root rot. In: NZ For. Ser. For. Res. Inst. Rep for 1960, pp 31.
- Gilmour, J.W. 1965: The life cycle of the fungal symbiont of *Sirex noctilio*. NZ J. For. 10: 80-89.
- Kershaw, D.J.; Gadgil, P.D.; Leggat, G.J.; Ray, J.W., and van der Pas, J.B. 1982: Assessment and control of *Dothistroma* needle blight, revised edition. NZFS FRI Bull. 18: 48p.
- Mac Kenzie M. 1987: Infection changes and volume loss in a 19-year old *Pinus radiata* stand affected by *Armillaria* root rot. NZ J. For. Sci. 17 (1): 100-108.
- Mac Kenzie, M. and Shaw, C.G. III. 1977: Spatial relationships between *Armillaria* root-rot of *Pinus radiata* seedlings and the stumps of indigenous trees. NZ J. For. Sci. 7(3): 374-383.
- van der Pas, J.B. 1981a: Impact and control of *Armillaria* root-rot in New Zealand pine plantations. In: Root and butt rots in Scotch (sic) pine stands. IUFRO working party S2.06-01 Polish Academy of Sciences. pp 69-77.
- _____ 1981b: A statistical appraisal of *Armillaria* root-rot in New Zealand plantations of *Pinus radiata*. NZ J. For. Sci. 11: 23-36.
- van der Pas, J.B. and Hood, I.A. 1985: The effect of site preparation on the incidence of *Armillaria* root-rot in *Pinus radiata* four years after conversion from indigenous forests in Omataroa forest, New Zealand.
- Peace, T.R. 1961: Pathology of trees and shrubs, with special reference to Britain. Oxford University Press. 753 pp.
- Roth, L.F.; Shaw, C.G. III, Mac Kenzie, M., and Crockett, F. 1979: Early patterns of *Armillaria* root-rot in New Zealand pine plantations converted from indigenous forest: An alternative interpretation. NZ J. For. Sci. 9(3): 316-363.
- Shaw, C.G. III and Calderon, S. 1977: Impact of *Armillaria* root-rot in plantations of *Pinus radiata* established on sites converted from indigenous forest. NZ J. For. Sci. 7(3): 359-377.
- Shaw, C.G. III and Toes, E.H.A. 1977: Impact of *Dothistroma* needle blight and *Armillaria* root-rot on diameter growth of *Pinus radiata*. Phytopathology 67: 1319-1323.
- Ure, J. 1950: The natural vegetation of the Kaingaroa plains as an indicator of site quality for exotic conifers. NZ J. Forestry 6(2): 112-123.

CHANGES IN THE INCIDENCE OF DWARF MISTLETOE OVER 30 YEARS IN THE SOUTHWEST

Helen Maffei and Jerome Beatty, USDA Forest Service, Southwestern Region, Forest Pest Management, Albuquerque, NM.

ABSTRACT.--Changes in incidence of dwarf mistletoe on ponderosa pine in the Southwest were assessed by surveying national forest system lands in Arizona and New Mexico and comparing the results of the survey to the results of a similar survey performed in the 1950's. Regionwide, dwarf mistletoe incidence has increased from 30% to 38%. Incidence has increased on all but two National Forests in the Region. This increase is probably due to several factors, including single tree selection, incomplete or inappropriate prescriptions to control mistletoe, and lack of priorities for treating mistletoe infected stands.

INTRODUCTION.--Dwarf mistletoe (Arceuthobium vaginatum subsp. cryptopodum) is the most important disease of ponderosa pine (Pinus ponderosa var. scopulorum engelm.) in the Southwest. An estimated 30% of the total 4 million acres of commercial ponderosa pine is infected. We have known how to silviculturally control dwarf mistletoe in ponderosa pine in the Southwest for many years. Yet, many in the Region have expressed the opinion that dwarf mistletoe is actually increasing in the ponderosa pine component. In order to evaluate this claim, Forest Pest Management Pathologists conducted surveys of the commercial ponderosa pine component in each of the eleven National Forests in the Region. This paper will present the results of these surveys and discuss what they indicate about the trend in dwarf mistletoe incidence in Southwestern ponderosa pine. Possible reasons for the apparent trend will also be discussed.

METHODS.--In the 1950's, Andrews and Daniels conducted a Regionwide, roadside surveys for dwarf mistletoe. The results of their surveys were used as references for infestation levels of ponderosa pine existing 30 years ago. Our survey methods were the same as the methods used by Andrews and Daniels. Estimates of change in mistletoe incidence were made by comparing the results of our surveys (in areas comparable to or if possible, the same roads that were surveyed by Andrews and Daniels) to the survey results of Andrews and Daniels. The original raw data and maps of travel routes from Andrews and Daniels study were used in the analysis. For consistency, one person (Rick Norris, Biological Technician, Forest Pest Management) decided which areas were comparable and performed the subsequent calculations. Regionwide incidence of dwarf mistletoe in the 1950's and 1980's was estimated by expanding the survey results to the total acres of commercial ponderosa pine presently on the Forest, totaling up those acres, and dividing by the total acres of commercial ponderosa pine in the Region.

RESULTS.--Regionwide level of dwarf mistletoe on a per acre basis apparently increased 8%; from 30% in 1958 to 38% in 1988. Estimated incidence levels by National Forest in 1950's ranged from 13% on the Cibola National Forest to 57%

on the Lincoln National Forest. Incidence in the 1980's ranged from 26% on the Carson National Forest to 64% on the Lincoln National Forest. Incidence increased on all but two of the eleven National Forests; the Apache-Sitgreaves National Forests and the Carson National Forest. On the Apache-Sitgreaves National Forests, mistletoe incidence decreased 1% and on the Carson National Forest it remained unchanged from the levels that were estimated by the 1950's survey. Dwarf mistletoe increased most dramatically on the Tonto National Forest (by 28%). The average increase in incidence by National Forest was 11%.

DISCUSSION AND CONCLUSION.--Dwarf mistletoe incidence appears to have increased over the past 30 years in the commercial ponderosa pine component of Southwestern National Forests. We think there are a number of factors contributing to the present situation:

1. In the Southwest, over the past 30 years, foresters have commonly practiced single tree selection. This practice was widely applied throughout the Region as "sanitation" or "salvage" prescriptions. Trees with dwarf mistletoe ratings of 3, or greater, were removed, but less severely infected trees remained. Infection then spread throughout the stand from the residual trees. This practice also increased the unevenaged character of stands whereby mistletoe could intensify more easily throughout the stand.

2. Ineffective prescriptions where mistletoe control is the object of the prescription may also have contributed to the increase in mistletoe. Many foresters have been reluctant to engage in the complete prescriptions necessary to control mistletoe. For example, they are hesitant to completely remove an infected overstory if such a removal will leave nonstocked gaps. As a result, infected overstory trees are left in the gaps and are a source of inoculum to adjacent uninfected trees as well as any regeneration which might come into the gaps.

3. Priority has not been given to treating mistletoe infected stands; especially to stands where management options would be lost if treatment was delayed. Many times, infected stands were selectively harvested with little thought, if any, to anything except getting the targeted volume.

REFERENCES

Andrews, S.R., and V.P Daniels. 1960. A survey of dwarf mistletoes in Arizona and New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Station Paper No. 49. 17 pp.

Hawksworth, F.G., 1961. Dwarfmistletoes of ponderosa pine in the Southwest. USDA Forest Service Technical Bull. 1246. 112 pp.

Hessburg, P.F., R.E. Wood and J.S. Beatty. 1985. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Apache-Sitgreaves National Forests, Arizona. R-3 85-10. 32 pp.

Hessburg, P.F., and J.S. Beatty. 1985. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Coconino National Forest, Arizona. R-3 85-12. 31 pp.

Hessburg, P.F. and J.S. Beatty. 1985. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Kaibab National Forest, Arizona. R-3 85-13. 30 pp.

Hessburg, P.F. and J.S. Beatty. 1986. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Lincoln National Forest, New Mexico. R-3 86-5. 30 pp.

Hessburg, P.F. and J.S. Beatty. 1986. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Santa Fe National Forest, New Mexico. R-3 86-6. 29 pp.

Beatty, J.S., P.F. Hessburg and H.M. Maffei. 1987. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Carson National Forest, New Mexico. R-3 87-5. 29 pp.

Maffei, H.M., J.S. Beatty and P.F. Hessburg. 1987. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Cibola National Forest, New Mexico. R-3 87-8. 27 pp.

Maffei, H.M., J.S. Beatty and P.F. Hessburg. 1987. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Prescott National Forest, Arizona. R-3 87-5. 27 pp.

Maffei, H.M., J.S. Beatty and P.F. Hessburg. 1987. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Gila National Forest, New Mexico. R-3 87-10. 29 pp.

Maffei, H.M., and J.S. Beatty. 1987. Incidence, severity and growth losses associated with ponderosa pine dwarf mistletoe on the Tonto and Coronado National Forests, Arizona. R-3 88-in press.

FOREST MANAGEMENT IN CALIFORNIA STATE PARKS

Mark E. Schultz

ABSTRACT

A pathologist, entomologist, and fire ecologist have cooperated with park managers in the treatment of four California state park for the reduction of tree mortality due to forest pests and fire. This has provided a unique opportunity for the management of state parks, the education of park personnel in forest ecology, and the publicizing of these three disciplines.

INTRODUCTION

The management of trees in the California state parks has been guided by the removal of hazardous trees. The 'Lee Paine' system of identifying hazardous trees has been used for many years and probably reduced the incidence of personal injury within parks (Paine, 1971). Also it provided methods that park managers used to locate possible removals and develop a system of management that could be defended in a court of law, insuring the state parks against large awards in property and injury lawsuits.

A program of stand management to reduce the future loss of trees due to insects, diseases, fire, and environmental factors was begun because a large number of trees were removed in the hazard tree removal program. The state department of parks and recreation contracted with the University of California at Berkeley to develop a series of methods to manage their developed and undeveloped sites. The program was begun at McArthur - Burney state park.

Management recommendations for forested stands involved silvicultural prescriptions and prescribed burning to increase the vigor of trees, increase species diversity, enhance structural diversity, reduce fire hazard, and to prepare sites for natural regeneration. Prescribed burning will recreate the historical appearance of state parks prior to fire exclusion. Selected tree removal will reduce tree mortality while maintaining forest esthetics.

The objectives of this project were to increase tree health, reduce the probability of pest caused mortality in the future, and to train state park personnel to identify important forest pests while putting into perspective the importance of pests and fire in shaping future forest stands.

Mark E. Schultz is a post graduate of the Dept. of Plant Pathology, University of California at Berkeley.

MANAGEMENT PRESCRIPTIONS AND PARK DESCRIPTIONS

Marking trees for removal began after field observations and discussion by an entomologist, fire ecologist, pathologist, and park manager. The relative importance of insects, fire, and pathogens for each site were considered. When any one of these three elements was an overriding influence then the person from that discipline became the team leader. These discussions were held with local park managers and regional ecologists of the state parks.

Only those trees were marked that could be removed shortly afterwards. Trees were marked on two sides with blue paint (dots). When pole size and larger diameter tree stands were marked a basal area per acre average was used as a guideline. When stands of sapling and small trees were marked a spacing or tree per acre method was used. Trees were marked on a basis of their hazard and vigor rating relative to their location. Hazard was a major component when trees were in developed sites, or next to trails and roads in undeveloped sites. The maintenance of vigor and the natural beauty of the stand was an overriding objective.

Removal was done with a feller - buncher or chain saw. California conservation crews were used when available to fell, remove trees, and grind stumps. Time of year, availability of crews, and budget were considerations. Removal could not be done during times of heavy visitor use or at a time when the insect population could be significantly increased by the creation of slash.

McArthur - Burney state park in the northern sierra mountains next to highway 89 was the first park marked and treated. Forest stands within this park are predominantly composed of the ponderosa pine (Pinus ponderosa), oak type (Oregon white oak, Quercus garryana; black oak, Q. kelloggii; and valley oak, Q. lobata) with some white fir (Abies concolor), Jeffery pine (Pinus jefferyi), and Douglas fir (Pseudotsuga menziesii). Much of the overstory pine and corresponding understory pine were infected with dwarf mistletoe (Arceuthobium campylopodum). Heavily infected trees were often infested with pine engraver beetle (Ips pini), mountain pine beetle (Dendroctonus ponderosae), and western pine beetle (Dendroctonus brevicomis). Overstocking generally occurred throughout the park and stands were separated by meadows and oak woodlands. Oaks were nurse trees under which ponderosa pine became established.

Donner state park is in the central sierra mountains near highway 80. It is predominantly lodgepole pine (Pinus contorta) type with some white fir and Jeffery pine. Many stands were overstocked with as much as 500 sq. ft. of basal area of trees per acre. Almost all of the trees in the developed sites were damaged so the type of damage was ranked to determine what trees would be removed. The major pest was mountain pine beetle in lodgepole pine. Basal wounds, multiple tops, western gall rust (Peridermium harknessii), lantern cankers (caused by hanging lanterns on trees), and stalactiform rust (Cronartium stalactiforme) were secondary causes of hazard and damage in order of their importance.

D. L. Bliss state park is in the Lake Tahoe basin area and is next to Lake Tahoe. Jeffery pine is the predominant stand type (with some sugar pine [Pine lambertiana] and white fir in the understory). The park also has mixed conifer (Jeffery pine, sugar pine and white fir), and white fir stands. Dwarf mistletoe in the jeffery pine, and annosus root rot

(Heterobasidion annosum) in the white fir are the major tree pests.

Sugar pine point state park is centrally located on the east side of Lake Tahoe next to highway 89. It has a combination of almost pure old growth Jeffery pine stands, Jeffery pine stands with white fir in the understory, and mixed conifer stands (of Jeffery pine, sugar pine, white fir, and red fir [Abies magnifica]). The problems are overstocking, dwarf mistletoe in the pine, insufficient screening between camp spots, and centers of annosus root rot in the white fir.

TREATMENTS

The amount of direct involvement of state park personnel in the marking and supervision of tree removal varied from region to region and park to park. With a minimum of training state park personnel quickly learned what trees should be removed and what trees could remain. Removals that would significantly lower site quality and were of low to medium hazard had to be confirmed by the park ecologist.

The final approach for marking McArthur - Burney state park trees for removal in undeveloped sites involved removal of pine in groups of 2 to 5 trees to increase spacing while selecting against trees with mistletoe. Openings were created so that a three wheel feller - buncher could maneuver within each stand without injury to residual trees. Since much of the area is overstocked with sapling to pole size trees (4 to 12 inches diameter breast height) removal could not be done by a feller - buncher because the operator would have to be paid out of the state park budget instead of by the sale of logs. The California conservation crews did the cutting, stacking, and piling of trees for only the cost of their expenses. No pruning will be done on the residual trees so that the natural appearance of the park can be maintained. Stumps were cut short but were not ground down. All pines under oaks were removed unless their removal would seriously injure the oak. Species diversity was preserved by not marking Douglas fir, oak, and white fir unless they were in pure overstocked groups.

The main prescription for Donner state park was to thin the lodgepole pine to increase vigor and reduce the possibility of epidemic populations of mountain pine beetle. If none of these types of damage occurred than undamaged trees were removed. A sense of esthetics was collectively determined by the university and the state for the removal of trees within the undeveloped areas. There were no trees with lantern cankers and few with basal wound within these areas. Removal was done in groups of 2 to 5 trees to maintain a sense of structure and natural spacing of trees. Fire was prescribed to prepare a seed bed for Jeffery pine and to maintain the stand structure. All snags were removed within 25 meters of a trail (at least tree height away) but only an average of 20 percent were selected beyond 25 meters. Multitop trees were not selected for removal in undeveloped stands unless trees of equal size and of perfect form also occupied the site. They were often the largest trees in the stand and provided the stand with that height class.

Mistletoe control in D. L. Bliss state park was the main stand prescription. Overstory pine within the infected area were removed as they died. There was a north and south extent of pine infection. A stand type change occurred at both boundaries. All Jeffery pines within the uninfected

boundary (150 ft. wide strip) next to the infection area were removed to slow the aerial spread of mistletoe. As clearings develop within the infection area from the removal of dead Jeffery pine, nonsusceptible resistant Jeffery pine, sugar pine, and white fir will be planted. Trees in developed areas will not be removed for mistletoe control because it could drastically change the character of these sites.

Sugar pine point state park had a combination of distinct problems. Much of the area is an old growth forest. Mistletoe was controlled in the undeveloped area by removal of all infected jeffery pine (mistletoe infection is not extensive). Old growth Jeffery pine were relieved of competition in some undeveloped stands by the removal of understory white fir. There were several trees with fire history from 5 to 7 fires of the past. These trees were identified and marked for dissection. Careful consideration of stands within the developed area will be considered because old growth trees in these sites make it a unique campground.

DISCUSSION

The University of California can not put itself in a position to be legally responsible for tree failure. The final decision of removal is left up to the park ecologists and managers. The university experts involved in the evaluation of these parks acted as an intermediary to help emphasize the importance of sound forest management so that confidence could be placed in a stand management plan. The treatment of the development campgrounds at McArthur - Burney and of the picnic area of Donner served as an example of how a cooperative effort could result in stands that are both esthetic and more healthy than the untreated control areas. Enough trees remain in treated areas so that insect mortality of residual trees could be removed after the main treatment without clear-cutting the site.

Complete removal of overstory Jeffery pine infected with mistletoe would completely clear some areas of trees in D. L. Bliss state park and result in a major logging operation. Gradual removal of dead trees would probably result in less public criticism and eventually prepare areas for planting.

The engagement of university experts in the management of state parks gives public exposure to forest pathology, forest entomology, and fire ecology as well as resulting in a tangible benefit for the state parks. Participation in the evening ranger programs further advertises the purpose and importance of pest and fire management. Management options to control pests and catastrophic fire are in many published reports but park managers find interpretation of the results difficult for their specific combination problems. Each prescription must be tailored to each stand. The physical involvement of these experts publicize the need for more research funding, and leads to the better husbanding of our recreation areas. It also helps the public understand the insidious nature of forest pathogens and the beneficial effects of prescribed burning.

LITERATURE CITED

Paine, L. A. 1971. Accident hazard evaluation and control decisions on forested recreation sites. USDA For. Serv. Res. Pap. PSW-68. 10p.

EVIDENCE OF VARIABILITY IN PATHOGENICITY AMONG ISOLATES FROM AN ISOZYMICALLY MONOMORPHIC POPULATION OF WESTERN GALL RUST

M.M. Chen¹, F.W. Cobb Jr.^{2,3}, W.J. Libby⁴, and D. R. Vogler⁵

ABSTRACT: Inocula of western gall rust, collected from more than 100 different trees in a radiata pine common-garden experiment, were isozymically monomorphic at 13 or more loci and polymorphic at none. Inocula collected from 10 trees in this common-garden experiment proved to have significantly different levels of virulence in greenhouse tests. These differences cannot yet be clearly identified as to genetic and/or physiological causation. The host clones used in the greenhouse tests were drawn from the common-garden plantation and, with the possible exception of some from Guadalupe Island, they generally maintained their relative levels of susceptibility in the field and in the greenhouse. Surprisingly, the more virulent isolates were originally collected on the more susceptible hosts, and vice-versa.

INTRODUCTION

In a preliminary sample of western gall rust [*Peridermium harknessii* J.P. Moore (previously called *Endocronartium harknessii*, see Epstein & Burlage 1988)] from a genetic-architecture experiment of radiata pine (*Pinus radiata* D. Don), no genetic variation was found among spore collections from 60 different trees, based on 13 isozyme loci (pers. comm., Brian Racin, Spring 1986). Complete monomorphism was similarly found in a 1987 sample of 52 single galls from trees in the same experiment, using 14 well-defined and 5 less-well-defined isozyme loci (Vogler and others 1987).

The work reported in this paper is from a study to further develop greenhouse inoculation procedures (Nelson 1971; Chen and others, in press), to relate host susceptibility in greenhouse and field conditions, and to investigate in a preliminary manner whether variation in pathogenicity exists within the isozymically monomorphic rust population.

MATERIALS AND METHODS

Host Plants

In a 1000-tree genetic-architecture experiment at the University of California's Russell Reservation (Old & others 1985, 1986), western gall rust infection varied from a low level in the northwest part of the plantation to an intense level in the plantation's southeast corner. Thirty-one host clones were chosen from this larger experiment for the study reported herein, and were meant

¹Visiting Scholar, Dept. of Plant Pathology, U. of California, Berkeley 94720 USA.

²Professor, Plant Pathology, U. of California, Berkeley 94720 USA.

³Names of second and subsequent authors are shown in alphabetical order.

⁴Professor, Forestry and Genetics, U. of California, Berkeley 94720 USA.

⁵Graduate Student, Dept. of Plant Pathology, U. of California, Berkeley, 94720 USA.

to include a range of host susceptibilities. The seedling ortets of five of these clones were in host class "0" (no galls); four of these seedlings were in the heavily-infected southeast part of the experiment, and all five were free of infection after two years' exposure. Five ortets were in host class "5"; these were the most heavily-infected seedlings in the plantation (each had 45 or more galls after two years' exposure), and they mostly came from the central and southeastern parts of the plantation. Host classes "1-4" had five, four, six and six clones, respectively, and were defined by having 1-3, 4-9, 10-21, and 22-44 galls, respectively, on their ortets. Furthermore, the seedling ortets for classes "1" and "2" were mostly from the heavily-infected southeastern part of the plantation, and those for classes "3" and "4" were mostly from the moderately- or lightly-infected central and western parts of the plantation. In other words, classes "1" and "2" contained clones whose ortets were lightly and moderately infected in heavily-infected neighborhoods, while classes "3" and "4" contained clones whose ortets were heavily and very heavily infected in moderately- or lightly-infected neighborhoods.

Each of these seedlings had been cloned prior to being outplanted. Two rooted cuttings (ramets) of each clone were maintained as 15-cm-high hedges in clay pots in a rust-free environment. These were the cutting donors for the plants (ramets, or stecklings) used as hosts in the greenhouse inoculations reported below.

Inocula

Ten isolates of inocula were collected, each from a single gall, during mid-April and early May 1985. Five were collected from the most-lightly-infected class of trees (class "1", above, inocula "6-10") and the other five were from the two most-heavily-infected classes (four from class "4", inocula "21-24" and one from class "5", inoculum "26"). When choosing a gall for spore collection, care was taken to avoid areas with multiple galls, and galls with sectors or nodes, on the presumption that a single gall with uniform morphology was more likely to have resulted from infection by a single spore. The spores were collected when the gall cracked open and seams of orange-yellow aeciospores were visible (Figure 1). The peridium covering the aeciospores was punctured with a hypodermic needle, and the spores beneath the surface were sucked into a sealed vial. Each isolate was then used, through inoculation and re-collection, to establish a "spore-line" for later experiments, and we refer to them as "spore-lines" in the remainder of this paper.

Inoculation Procedures

From one to twenty ramets of each of the 31 host clones (average 11.7 ramets per clone) were inoculated with the collected spores. In this experiment, each ramet received inocula from only one spore-line, from one collection. The spore-lines were assigned to clones in a systematic manner, arranged such that each class of host clones received approximately equal numbers of inoculations from each spore-line, but no one clone was inoculated with all ten lines (maximum five spore-lines per clone). Those four clones with only 1-5 ramets per clone had each ramet assigned to a different spore-line. The remaining 27 clones had more than one ramet assigned to a given spore-line, such that two spore-lines from the lightly-infected hosts (inocula "6-10") and two spore-lines from the heavily-infected hosts (inocula "21-26") were applied to approximately equal numbers of ramets in the clone. In 6 clones, 1-3 ramets were inoculated with a fifth spore-line, to achieve balance among spore-lines in total inoculations and within the six host classes with respect to the two inoculum classes. A few of the ramets died between inoculation and scoring, resulting in some imbalances at the time of scoring, but approximately equal numbers of inoculations within host classes between inoculum classes were achieved (Table 1).



Figure 1. Gall on yearling branch resulting from infection approximately 11 months earlier, shortly after collection of spores from the aeciospore-filled fissures.

Following preliminary trials using scarified and unscarified host tissue, and dry and aqueous-suspension applications of spores, the following procedure was found to be reliable and was used uniformly for the inoculations reported below. Host ramets were grown in a greenhouse until the root systems were well established and the main shoot was actively elongating behind a terminal meristem in free-growth phase. Dry spores were taken from the vial and brushed onto a region of approx. 1 cm length, 2 cm below the terminal meristem. Inoculations were performed on 6 September 1985 and on 6 February 1986. The newly-inoculated ramets were placed in a mist chamber at 21°C for 48 hours, and were then grown in the greenhouse for six months at ambient 23-24°C.

Scoring

Each ramet was classified as to gall symptoms three and six months after inoculation. Classes "0-2" were weakly infected or uninfected, as follows: Class "0" had no symptoms or injuries in the inoculated region; class "1" had a lesion or other suspicious symptom in the inoculated region but no visible swelling; and class "2" had suspicious short-shoot development in the inoculated region but no visible swelling. Classes "3-5" were infected, as follows: class "3" had one moderate swelling in the inoculated region; class "4" had more than one moderate swelling in the inoculated region; and class "5" had one or more large galls in the inoculated region (Figure 2).

During the period between the 3-month and 6-month observations, there was a failure in plant care for a short period that resulted in the deaths of 147 of the 362 ramets scored at 3 months. Scores for the 215 ramets that survived and recovered healthy growth by 6 months were as follows. Of the 143 ramets scored in classes "0-2" at 3 months, 135 were again scored in classes "0-2" at 6 months; of the 72 ramets scored in classes "3-5" at 3 months, all 72 were again scored in classes "3-5" at 6 months. None of the 215 ramets was given a lower score at 6 months than at

TABLE 1 -- Scored surviving ramets of *Pinus radiata* by spore-line inoculated and host class.

Host Class ²	Spore-lines ¹											
	6	7	8	9	10	6-10	21	22	23	24	26	21-26
0	5	5	3	2	2	17	5	4	3	2	3	17
1	8	5	6	5	3	27	6	4	7	5	6	28
2	2	3	3	2	1	11	1	3	3	3	0	10
3	6	7	7	10	12	42	7	5	9	11	9	41
4	10	8	9	8	11	46	11	8	9	7	11	46
5	7	10	7	6	10	40	12	6	5	8	6	37
Σ	38	38	35	33	39	183	42	30	36	36	35	179

¹Spore-lines "6-10" from lightly-infected hosts in heavily-infected neighborhoods; and spore-lines "21-26" from heavily-infected hosts in lightly-or-moderately-infected neighborhoods, or ("26") a heavily-infected neighborhood.

²Class of host clones: from uninfected ("0") to heavily-infected ("5") ortets in the plantation environment (4-6 clones per class).

3 months. Of the 16 ramets scored "3" at 3 months, 6 were scored "3" and 10 were scored "5" at 6 months; similarly, of the 25 ramets scored "4" at 3 months, 6 were scored "4" and 19 were scored "5" at 6 months. In sharp contrast, of the 143 ramets in the "0-2" classes at 3 months, only 1 was scored "5" at 6 months. Of the 128 "0" ramets at 3 months, 121 were still "0"s at 6 months, 1 was a "2", and 6 were scored "3". Of the 7 "1" ramets at 3 months, 5 were still "1"s at 6 months, 1 was a "2", and 1 was the "5". Of the 8 "2" ramets at 3 months, 7 were still "2"s at 6 months and 1 was a "3".

These observations led us to conclude that classes "0-2" and "3-5" were useful groupings for "uninfected or weakly infected" and for "infected". Furthermore, few ramets scored "0-2" at 3 months were changed in status to "3-5" at 6 months, and the reverse (from "3-5" to "0-2") was not observed in 72 opportunities. We therefore opted to use the full data set for 362 ramets at 3 months (those in Table 1), rather than the slightly more accurate data set for only 215 ramets at 6 months.

Beginning 11 months after inoculation, the rust fungus in class "5" galls began to produce aeciospores, providing ongoing replicates of 9 of the 10 inoculum lines, to be used in further experiments.

Statistical Analyses

As explained above, this was a preliminary experiment performed before we had replicate collections of the spore-lines, and when we had only 1-20 available ramets of each of the 31 host clones. No host clone was inoculated with all 10 spore-lines; in fact most host clones were

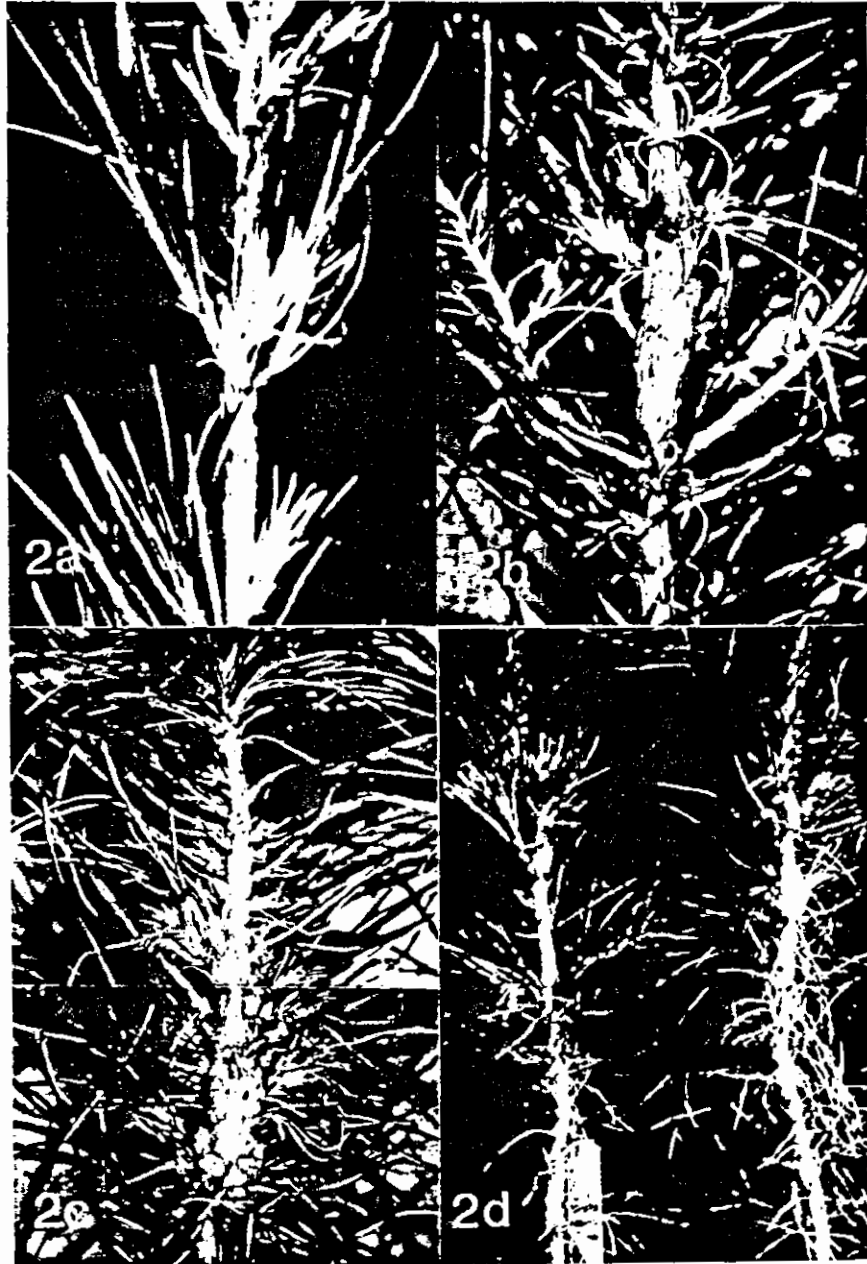


Figure 2. Ramets showing various symptoms 3 months after inoculation:

- 2a. Short-shoot development, but little or no swelling - class "2".
- 2b. Moderate swelling in the inoculated region - class "3".
- 2c. Several swellings in the inoculated region - class "4". Note also the developing short-shoots.
- 2d. One and two large swellings in the inoculated region - class "5". Note continuing long-shoot development from short-shoots on the galls.

inoculated with either 4 or 5 spore-lines. Since we knew that these hosts had different susceptibilities in field conditions (Old & others 1985, 1986; Zagory & Libby 1985), we suspected that they would also differ in susceptibility in greenhouse conditions with artificial inoculations. Because of the small numbers of ramets per clone and the complication of different spore-lines being used on different clones, we did not attempt to characterize host-clone susceptibilities. Because there were similar numbers of ramets in each host-class inoculated with spore-lines "6-10" and "21-26" (Table 1), we did analyse infection by host classes, using the non-parametric Chi-square statistic.

Our main interest was in developing evidence whether these isozymically uniform spore-lines exhibited different pathogenicities. The null hypothesis is that there is no difference between spore-lines. To eliminate the expected effect of different susceptibilities among host clones, we made each host clone an experimental unit. Under the null hypothesis, the probability of infecting each ramet of a particular clone should be the same, no matter which spore-line contributed the spores. To evaluate this, we took the percentage of ramets infected by all spore-lines used on a host clone (typically two from spore-lines "6-10" and two from spore-lines "21-26") to generate a predicted number of infected ramets for each spore-line used on that host clone. We tested the null hypothesis using two non-parametric statistical methods. The first was a Sign Test. Each spore-line was used on 10-13 different clones that generated valid data. Under the null hypothesis, each spore-line should generate approximately equal numbers of plus and minus departures from the various host clones' predicted number of infections. The second was a Runs Test. In this, not only the sign but the size of the observed departure is taken into account. Data (departures from null-hypothesis expectations) from pairs of spore-lines are then combined and put in rank order, with the spore-line identity of each point also maintained. If the data for both spore-lines are drawn from the same set (the null hypothesis), the number of times adjacent ordered data entries are expected to be from the same or different spore-lines can be determined, with probabilities for various outcomes. If the data for the paired spore-lines are drawn from different sets, however, the frequencies of adjacent data-entries being from the same spore-line increase, while the frequencies of being from different spore-lines decrease (Dixon & Massey 1951).

RESULTS AND DISCUSSION

Host Classes

The upper part of Table 2 presents infection percentages of each of the 4-6 clones in each host class. Each clone's population of origin is coded to footnote 1 in the Table. Average infection percentage for the entire experiment was 43.1%.

The single-host-clone data are not reliable, being based on small numbers of inoculations per clone (1-20, avg. 11.7), and with different sets of four or five spore-lines used on each host clone. In spite of this unreliability, the variation is far from random. Of the 20 clones in host classes "0-3", only four exceed the average infection level of 43.1%. In sharp contrast, all six clones of host class "4" exceed 43.1% infection, as do three of the five host-class "5" clones.

In the field experiment where the ortets of these clones were selected, the two most susceptible native population-samples were from Cambria and Monterey (Old & others 1985, 1986). The six Cambria-origin clones in Table 2 average 65.2% infection, with only one of them being below 43.1%. The three Monterey-origin clones average 41.3% infection. The Año Nuevo population-sample was much less susceptible than those of Cambria and Monterey in the field, and the three Año Nuevo-origin clones average only 15.7% infection. The Australia-New Zealand landrace was intermediate in susceptibility between the Monterey and Año Nuevo populations, its populations of

TABLE 2. Clones in host classes "0-5" ranked by percentage of ramets in each clone in infection-classes "3-5".

	Host Class ¹					
	0	1	2	3	4	5
	L- 0%*	L- 0%*	Z-17%	TxM- 8%	M-44%	T- 7%
	T-12%	A- 7%	Z-20%	Z-36%	L-46%	A-11%
	Z-33%	LxA-13%	A-29%	M-38%	LxC-65%	Z-47%
	L-33%	AxC-44%	LxT-67%	C-38%	C-71%	C-55%
	Z-38%	L-67%		M-42%	Z-76%	C-93%
				C-47%	C-87%	
Number Attempted Inoculations (Ramets)	34	55	21	83	92	77
(1) Percent of Host-class Ramets in Infection-classes "3-5"	29%	27%	29%	35%	65%	47%
(2) Average of Clonal Percentages of "3-5" Ramets	23%	26%	33%	35%	65%	43%

¹Host origin population: A - Año Nuevo, C - Cambria, L - Guadalupe Is., M - Monterey, T - Cedros Is., Z - Australia-New Zealand landrace, LxA - Guadalupe x Año Nuevo hybrid. Percentages based on (the ramets scored in infection classes "3-5") + (the number of surviving ramets inoculated) per clone.

*These two uninfected clones were not used in further data analyses.

(1) (Total number of ramets scoring "3-5") + (number of surviving ramets in the host class)

(2) (Sum of the "3-5" ramets percentage by clone) + (number of clones in the host class)

origin, in the field experiment. The seven clones of this landrace in Table 2 average 38.1% infection. The Cedros and Guadalupe Island population-samples were the least susceptible in the field experiment. The two Cedros-origin clones average 9.5% infection, but the five Guadalupe-origin clones average 29.2% infection. Furthermore, a hybrid Guadalupe x Cedros clone was one of the two host-class "0-3" clones with greater than 50% infection, a Guadalupe clone being the other. While these clones were not random draws from the different population-samples, it does appear that their rank-order of susceptibility is almost identical to that of their random population-samples of ortets in the field. Thus there is little evidence of interaction of maturation-state (the ramets of the host clones were more mature in this experiment than were their field ortets, see

Zagory & Libby 1985), growing environment (field vs greenhouse) or inoculation method (natural vs artificial) with host susceptibility. The possible exception to this is that some clones of the Guadalupe population may be relatively more susceptible to artificial inoculation and/or in the greenhouse environment.

The lower half of Table 2 presents the percentages of ramets in infection classes "3-5" by host class. These numbers are more reliable than those for individual clones, both because they are based on larger numbers of ramets (34-92 per class), and because similar proportions of the ten spore-lines were applied to the clones of each host class (see Table 1). Statistical analysis indicated that the differences in infection among the six host-classes (line [1], Table 2) are highly significant ($X^2=18.1$, 5 d.f., $p<.01$). Host classes "0-3" are all below average in infection percent, while host classes "4" and "5" are both above-average. Unweighted averages of clonal infection percentages provide a similar result (line [2], Table 2).

The ortets of the five clones in infection class "5" all were growing in blocks in the most heavily-infected portion of the field experiment. The ortets of the six clones in infection class "4", by contrast, were growing in lightly-infected or moderately-infected parts of the field experiment. Table 2 provides some evidence that the criteria used to choose clones for host class "4" more consistently identified susceptible hosts than did picking heavily-infected ortets in heavily-infected parts of the plantation (host class "5").

It may be noted that the clones in host classes "0-2" provided fewer ramets per clone (6.8, 11.0 and 5.2 respectively) than did the clones in host classes "3-5" (13.8, 15.3 and 15.4 respectively). This is due to a combination of numbers of cuttings per donor hedge, rooting percentages of the cuttings and survival of the newly-rooted cuttings. Statistical analysis indicated that the differences in ramets per clone among the six host-classes are highly significant ($X^2=39.6$, 5 d.f., $p<.001$). This relationship between susceptibility and rate of clonal expansion has been noted in one other experiment (WJL—unpublished data), although not consistently. The opposite result (faster clonal expansion of the more resistant clones) has not been observed. If the relationship is real, it may be related to differential maturation rates of the different clones (see Fig. 1, Burdon and Bannister 1973), and the relationship of maturation state to vegetative proliferation (Libby, Fanger-Vexler & Russell 1985), to rooting effectiveness (Libby & Conkle 1966), and to susceptibility to western gall rust (Zagory & Libby 1985).

Spore-lines

Figure 3 shows the cumulative above-expected-numbers of ramets per clone in infection classes "3-5" (positive bars), and below-expected-numbers of ramets per clone in infection classes "3-5" (negative bars). Note that none of the ten spore-lines produced infection rates that were 100% above-expected or 100% below-expected on all host clones.

Figure 4 shows the net departures of the ten spore-lines from expected infection rates. From this, it appears that the spore-lines may be ranked and clustered as follows: spore-lines "6", "8", "21" and "9" in a group of below-average infectivity; spore-lines "7", "10", "23" and "24" in a group of about average infectivity; and spore-lines "22" and "26" in a group of above-average infectivity.

Table 3 presents spore-lines in the above rank order, and a Sign Test for each spore-line. Four of the ten spore-lines had statistically unlikely departures from average infectivity, as tested by a Sign Test. The Sign Test supports the groupings based on net departures, above, with spore-

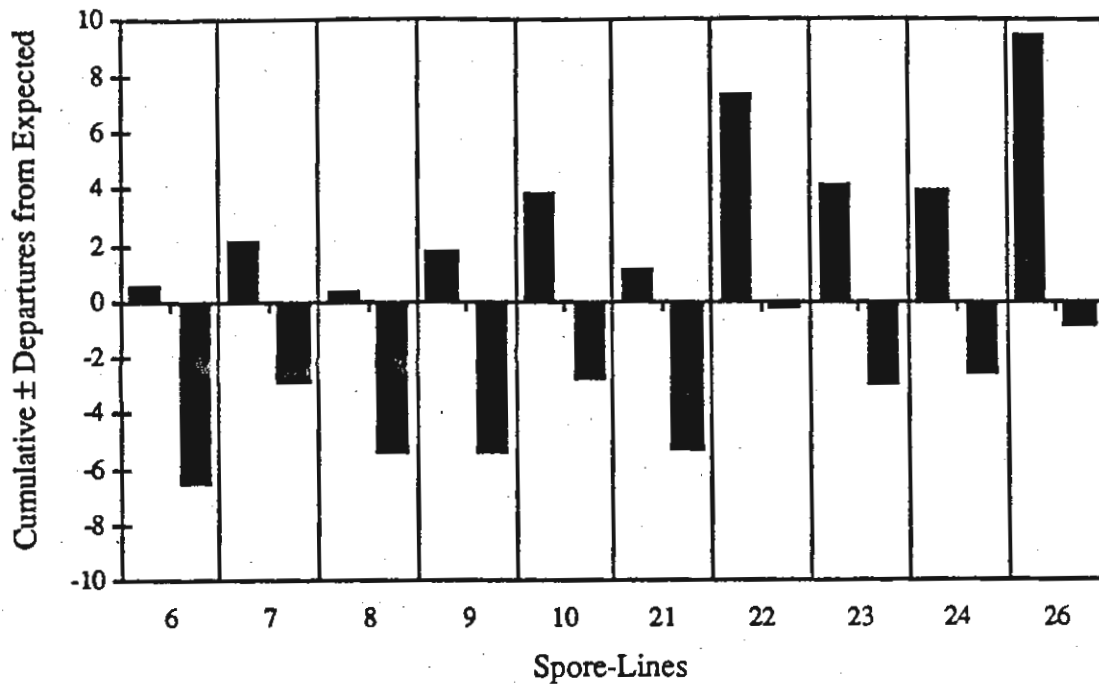


Figure 3. Departures from expected infection rates of the ten spore-lines. The positive bar indicates that an infection rate above the host-clone average was observed for one or more host clones, with the height of the bar summing large and small positive departures from expected. The negative bar similarly indicates summed departures of infection rates below host-clone averages.

lines "6", "8", "21" and "9" all having more than twice as many minus as plus departures, spore-lines "7", "10", "23" and "24" all having about equal numbers of plus and minus departures, and spore-lines "22" and "26" both having 5 times as many plus as minus departures.

Runs Tests on these data (see Materials & Methods) also tended to support these groupings. Spore-lines "6" and "8" were both highly significantly different from spore-lines "22" and "26" ($p < .01$). Spore-line "21" differed from "26" ($p < .01$) and "22" ($p < .05$). Interestingly, spore-line "9" did not significantly differ from "26" or "22", but spore-line "7" significantly differed from "26" ($p < .05$). No other pairs were significantly different.

At the time that we collected these spore-lines, we thought it possible that the spore cloud was of similar composition (although of different density) over the entire plantation. Thus, in any given area, the more-heavily-infected trees were permissive hosts for many kinds of spores, while the lightly-infected trees were permissive hosts for only a small subset of those. We therefore thought that only the more virulent spore-lines would have been successful on host class "1" (lines "6-10"), while at least some of the spore-lines from the more susceptible hosts would have been less virulent. The data do not support this idea (see Figure 4). The two most infective spore-lines ("22" and "26") are from heavily-infected trees in host classes "4" and "5", while the two least infective spore-lines ("6" and "8"), are from host class "1". Spore-lines "22" and "26" were both collected from host seedlings of the Cambria population (the most susceptible), while spore-line "6" came from a Cedros host and spore-line "8" came from a Guadalupe host, the two most resistant populations in the field experiment.

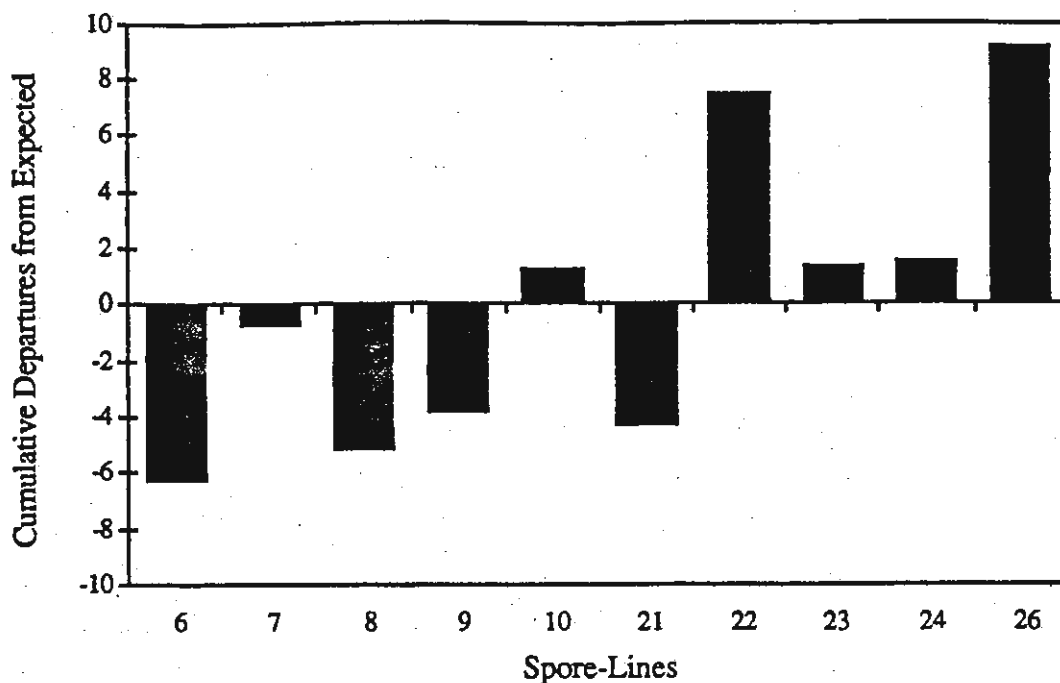


Figure 4. Combined departures from expected infection rates of the ten spore-lines. Figure 4 combines the positive and negative bars of Figure 3 into a net departure bar. Spore-lines "6-10" are from lightly-infected hosts and "21-26" are from heavily-infected hosts.

TABLE 3. Rank-order of spore-lines by net departures from expected infection rates¹.

Departures ²	Spore-lines									
	6	8	21	9	7	10	23	24	22	26
+	2	1	3	3	5	6	5	6	10	10
-	11	11	10	7	8	5	7	7	2	2
Probability ²	<.05*	<.01**	<.10	>.25	>.25	>.25	>.25	>.25	<.05*	<.05*

¹Based on Figure 4.

²For each clone inoculated with the spore-line, either more ramets than expected were infected (one +) or less were (one -). For example, 13 clones were inoculated with spore-line "6". Line "6" spores caused greater than clonal-average infection rates in 2 clones, but less than clonal-average infection rates in the other 11 clones, a result that is statistically unlikely (<.05 and significant -*) according to the Sign Test, given the null hypothesis that all spore-lines were equally infective.

GENERAL DISCUSSION AND CONCLUSIONS

This preliminary experiment has served to expand our supply of the inoculum lines, through multiple infections and re-collections. We have also begun to characterize the 31 included host clones as cutting production from their donor hedges was increasing. We have also tested our inoculation procedure, and have gained experience and confidence in early scoring of infection success.

The data produced during these activities indicate that the relative susceptibility of naturally-infected seedling ortets in the field was generally maintained by their artificially-inoculated steckling ramets in the greenhouse. Numbers of available ramets per clone did not permit analyses of specific host-clone/spore-line interactions, but contrasting host clones and spore-lines were identified to make such planned experiments more effective.

The analyses used produced statistically convincing evidence that all ten spore-lines did not behave identically on the host clones. Rather, we found two strongly-infective spore-lines and two weakly-infective spore-lines, and all four of these were of origins opposite to those anticipated. We emphasize here that, while we have demonstrated performance differences among the spore-lines, we have not demonstrated genetic differences as the basis of such performance. It might be that there were physiological differences among the spore-lines, as a result of differences in storage environment, or differences in condition at the time of collection, or even differences somehow imposed by their relatively resistant and susceptible ortet hosts. The re-collection of these lines from a variety of hosts, and their testing in larger numbers on a set of increasingly-known host clones, should serve to provide evidence on the presence of genetic differences in virulence among them.

ACKNOWLEDGEMENTS

This work was supported in part by PSW/UCB Coop Agreement-PSW-870004CA; manuscript preparation was supported in part by USDA Competitive Grant 86-FSTY-9-0191. We thank Weiching Wang and Kun Jin for statistical help and advice, Tina Popenuck for help in collecting the spores, and Ang-he Zhang and Evelyn Chung for help in raising the plants.

LITERATURE CITED

- Burdon, R.D., and M. H. Bannister. 1973. Provenances of *Pinus radiata*: their early performance and silvicultural potential. N. Z. J. For. 18: 217-232.
- Dixon, W.J., and F.J. Massey, 1951. Introduction to Statistical Analysis. Chap. 17.3. McGraw Hill. NY. 370 pp.
- Epstein, L., and M.B. Buurlage. 1988. Nuclear division in germinating aeciospores and its taxonomic significance for the western gall rust fungus, *Peridermium harknessii*. Mycologia 80: 235-240.
- Nelson, D.L. 1971. The Ecology and Pathology of Pine Gall Rust in California. PhD dissertation. Univ. Calif. Berkeley. 160 pp.

- Libby, W.J., and M.T. Conkle. 1966. Effects of auxin treatment, tree age, tree vigor and cold storage on rooting young Monterey pine. *Forest Science*. 12:484-505.
- Libby, W.J., L.J. Fanger-Vexler, and J.H. Russell. 1985. A population study of Monterey pines evaluated as Christmas trees. Final Report to the Calif. Christmas Tree Growers Assn., 19 pp.
- Old, K.M., W.J. Libby, and J.H. Russell. 1985. Patterns of susceptibility to western gall rust in *Pinus radiata*. Pages 285-305 in *Proc. of the Rusts of Hard Pines Working Party Conference. IUFRO S2.06-10*. U. of Georgia, Athens. Eds. J.H. Barrows-Broadus and H.R. Powers. 331 pp.
- Old, K.M., W.J. Libby, J.H. Russell, and K.G. Eldridge. 1986. Genetic variability in susceptibility of *Pinus radiata* to western gall rust. *Silvae Genetica* 35:145-149.
- Vogler, D.R., B.B. Kinloch, F.W. Cobb Jr., and T.L. Popenuck. 1987. Isozyme patterns in *Endocronartium harknessii* from several pine hosts and stands in California. (Abstr.). *Phytopathology* 77:1242.
- Zagory, D., and W.J. Libby. 1985. Maturation-related resistance of radiata pine to western gall rust. *Phytopathology* 75:1443-1447.

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE, PARK CITY, UTAH

DWARF MISTLETOE COMMITTEE REPORT - 1988

J. MUIR - COMPILER

TAXONOMY, HOSTS, DISTRIBUTION

- 1.1 Several Jeffrey pines (*Pinus jeffreyi*) in California considered to be highly resistant to dwarf mistletoe *Arceuthobium campylopodum* have been grafted onto seedling rootstock. These genetically identical trees will be used for further testing for resistance in the field and greenhouse, and for the establishment of a "clone" bank of resistant material for the future. (Bob Scharpf, PSW, Berkeley).
- 1.2 Studies on the "races" of the hemlock dwarf mistletoe are continuing. Field evidence confirms the existence of three taxa: (1), on western hemlock from Alaska to NW California, (2), on shore pine in Vancouver Island, coastal B.C. and Orcas Island, Washington, and (3), on mountain hemlock and western white pine from central Oregon to central California. Isozyme studies show that the mountain hemlock/western white pine "race" is most distinct and perhaps should be recognized at the subspecies level. (F. Hawksworth, USFS, RM Station and D. Nickrent, Univ. of Illinois).
- 1.3 Studies of the *Arceuthobium campylopodum-occidentale* complex on hard pines in California and adjacent Oregon confirm that this is indeed much more complex than implied in a certain DM monograph. The available evidence now suggests that at least four taxa, of as yet undetermined taxonomic status, are involved: (1) *A. campylopodum* primarily on ponderosa and Jeffrey pines, but also on Digger pine at higher elevations of the Digger pine type, (2) *A. occidentale* primarily on Digger pine, (3) a taxon on bishop and Monterey pines in coastal California, and (4) another taxon primarily on knobcone pine in the Siskiyou country of NW California and adjacent SW Oregon. Morphological, histological, phenological, and isozymological studies are continuing to help determine the appropriate taxonomic status of these taxa. (F. Hawksworth, USFS, RM Station; D. Wiens, Univ. of Utah; D. Nickrent, Univ. of Illinois; R. Mathiasen, Nor. Ariz. Univ.).

- 1.4 Studies of the common dwarf mistletoe on western white pine in the Siskiyou country of SW Oregon and NW California show that it is not the sugar pine dwarf mistletoe (A. californicum) as once thought, but a distinct taxon. The two mistletoes are apparently not sympatric, and A. californicum is now thought to be restricted to California. Stay tuned. (F. Hawksworth, USFS, RM Station; D. Wiens, Univ. of Utah; D. Nickrent, Univ. of Illinois, R. Mathiasen, Nor. Ariz. Univ.).
- 1.5 European mistletoe Viscum album was discovered in Victoria, British Columbia by C. Dorworth, and identified by F.G. Hawksworth. One infected apple tree with one male mistletoe plant was found. Future action on this new pest introduction to Canada will probably include surveys to determine the extent of the infestation and an eradication program in cooperation with the Canadian Forestry Service and Agriculture Canada Plant Protection. (J. Muir, B.C. Forest Service, Victoria).

2. PHYSIOLOGY AND ANATOMY

- 2.1 A manuscript summarizing the literature and our research results on anatomy of dwarf mistletoe shoots and endophytic systems is being finished for incorporation into the revised Hawksworth-Wiens monograph on dwarf mistletoes.

C. Calvin and L. Kirkpatrick, Portland State University.

3. LIFE CYCLE STUDIES

- 3.1 A summary paper on our studies on bird and animal vectors of lodgepole pine dwarf mistletoe seeds is to be published in the Colorado Field Ornithologists Journal. Seeds were found on 10 species of birds and 3 mammals. During the peak seed dispersal, about 20% of the birds netted carried mistletoe seeds. The birds that carried most seeds were gray jay, Steller's jay, and mountain checkadee. Isolated, presumably bird induced, infection centers were found more than 200 feet away from the closest infection source. (T. Nicholls and L. Egeland, USFS, NC Station, and F. Hawksworth, USFS, RM Station).
- 3.2 A 20-year re-examination was made on the study on spread and intensification of mistletoe in young western larch on the Coram Experimental Forest in Montana. The original plan was to measure spread and intensification under three spacings (8 X 8, 14 X 14, and 20 X 20 feet). However, since bears liked the plot so much and killed about half the inoculated trees, the original study plan had to be abandoned but we can still get some useful information from the plots. Forty inoculated trees survive and have spread mistletoe to 55 adjacent trees; the farthest newly infected tree was 4.7 meters from an inoculated tree. Data on intensification and upward spread will be analyzed this winter but it is obvious that annual upward spread of the parasite is considerably less than the annual height growth of the trees. (E. Wicker and F. Hawksworth, USFS, RM Station).

- 3.3 A study is being conducted to quantify reproduction of several conifers in various types of mixed conifer stands in the Southwest (including the frequency and abundance of dwarf mistletoe) for a growth and yield model. Preliminary results confirm previous findings that infection of Douglas-firs under about 20-25 years old is quite low, except under very heavily infested overstories. The results will be analyzed this winter. (R. Mathiasen, Nor. Ariz. Univ).
- 3.4 A Ph.D. study of the reproductive biology of Arceuthobium americanum on jack pine was made at the University of Manitoba. Studies were made on the phenology of flowering, pollen dispersal, and seed dispersal. Pollen loads were recorded in a volumetric spore trap and flower and another opening monitored by time-lapse photography. Male flowers opened on April 6 in 1987 but not until April 20 in 1986, a much colder year. Sugar concentration of the nectar on male flowers ranged from 30 to 65%. Opening of anthers in response to rising temperatures and falling humidity, and closing under the opposite conditions, was recorded for the first time in Arceuthobium. Both insects and wind are involved in pollination. Germination of Arceuthobium pollen was studied for the first time, and the percent germination was found to increase as the season progressed. Over-winter survival of maturing fruits was about 90% but about 30% were lost during the second summer due to dry, hot weather and parasitic fungi (Hallrothiella arceuthobii and Colletotrichum gloeosporioides). Peak seed dispersal occurred between 9:00 and 11:00 a.m. Seeds were dispersed up to 18 m from the source plant. About 5% of the birds netted carried mistletoe seed. Birds with seeds were: gray jay, junco, brown creeper, red-breasted nuthatch, and Swainson's thrush. Over-wintering survival of seeds on jack pine twigs was high; but there were considerable loss during the subsequent summer. Seed germination was nearly 90% in 1986, but only about 50% during the unusually dry spring of 1987. Details are being presented in a manuscript prepared by the Canadian Journal of Forestry Research. (J. Gilbert and D. Punter (Major Professor), Dept. Botany, Univ. of Manitoba).

4. HOST-PARASITE RELATIONS

- 4.1 Studies were made on the rates of intensification of Douglas-fir dwarf mistletoe for incorporation into a growth and yield simulation model for mixed conifer stands in the Southwest. About 500 Douglas-firs in Arizona and New Mexico were dissected to compare current dwarf mistletoe ratings (DMR) with the estimated ratings 10 years previously. A series of logistic equations were developed to predict the proportion of infected trees that will increase 1, 2, or more DMR classes in 10 years. The intensification rate increases with dbh and tree DMR class but decreases with stand basal area and stand DMR. On the average for all stand and tree parameters sampled, the trees increased about 1 DMR class in 10 years. (R. Mathiasen, Nor. Ariz. Univ; B. Geils, USFS, RM Station).

- 4.2 Arceuthobium occidentale growing on Digger pine (Pinus sabiniana) in the Sierra Nevada foothills was found infecting six year old Scotch pine (P. sylvestris) in a Christmas tree planting. Scotch pines within mistletoe seed dispersal distance of the overstory Digger pines were heavily infected. Four year old knobcone - Monterey hybrid pines (P. attenu radiata) also grown for Christmas trees and near infected Digger pines were mistletoe-free. (Bob Scharpf - PSW, Berkeley and Art McCain UC, Berkeley).
- 4.3 Germinated seeds of Arceuthobium californicum have been placed on actively growing callus of sugar pine (Pinus lambertiana) in culture. To date, no infection or tissue reaction has taken place. (Bob Scharpf - PSW, Berkeley).

5. EFFECTS ON HOSTS

- 5.1 Re-examinations were made of forest inventory plots established at least 10 years previously to see if they will give us reliable data on mortality and dwarf mistletoe intensification in Douglas-fir. The work was conducted in two regions (Southwest-Arizona and New Mexico) and in the Pacific Northwest (Oregon and Washington). In the Southwest, data were obtained for 1032 Douglas-firs on 54 plots in Apache-Sitgreaves, Carson, Lincoln, and Santa Fe National Forests. In the Northwest, data were obtained for 3,873 Douglas-firs on 106 plots on the Okanagan, Willowa-Whitman, and Wenatchee ("Toe Jungle") National Forests. The results will be analyzed this winter. (G. Filip, USFS, PNW Station; B. Geils, M. Marsden, J. Sprackling, T. Shaw, USFS, RM Station).
- 5.2 The first five year examination was made of a dwarf mistletoe sanitation and thinning study in lodgepole pine on the Targhee National Forest, Idaho. Sixteen plots of about 100 trees each were established in 1983: 4 replicates of 4 treatments (no thinning, 8 X 8, 11 X 11, and 14 X 14 foot spacing). The results will be summarized this winter. (J. Hoffman, USFS, R-4 1/2, Boise; J. Sprackling, USFS, RM Station).
- 5.3 Results from a sanitation and thinning study in infested lodgepole pine on the Routt National Forest, in northern Colorado show a marked difference in unthinned vs. sanitation-thinned plots after 21 years. For example, in 1986, the average dbh on the treated plots was 1.7 inches greater than on the untreated plots. Average stand dwarf mistletoe ratings went from 0.6 to 1.4 on the untreated plots compared with from 0.6 to 0.3 on the treated plots. Such low levels of infection on the treated plots suggest that dwarf mistletoe will have little effect on growth for several decades. Projections using the RMYLD growth and yield simulation program suggest that yields over the next 60 years will be nearly 4 times greater in the treated stands than in the untreated stands. (F. Hawksworth, USFS, RM Station; D. Johnson, USFS, RM Region; B. Geils, USFS, RM Station).

5.4 The variant of the Prognosis growth and yield model for Southeastern Oregon and Northern California (SORNEC) has a dwarf mistletoe submodel within it. However, the Forest Pest Management staff in the Pacific Northwest Region expressed their opinion that the model did not represent enough of an impact for the infestation level. Katherine Sleavin (WO-TM, Fort Collins, CO) made some test runs of the model which indeed demonstrated a lack of effect regardless of the level of dwarf mistletoe in the stand. Since then I have made several runs with a test set of stands from the region, these runs show a strong effect of dwarf mistletoe on stand development. The difference is in the mortality option used in Prognosis not in the pest component. Mortality option 3 imposes tree mortality on trees within a species and diameter group which are growing slowly compared to its potential growth. Ralph Johnson (WO-TM, Fort Collins, CO) modified the SORNEC model so this potential growth is for an open grown tree of that species on that plot condition. Our RM Station Project has several tasks started to check the spread and intensification data for dwarf mistletoe used in the model. Mortality rates are more difficult to test. (M. Marsden USFS, RM Station, Fort Collins).

5.5 The first 5-year reading of 16 permanent, 100-tree plots established in 1983 in lodgepole pine stands on the Targhee National Forest, Idaho, was conducted with the assistance of personnel from the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. The objectives of this evaluation are to determine the following:

1. The effects of precommercial thinning on growth of lodgepole pine stands infected with various intensity levels of dwarf mistletoe parasitism;
2. The effects of dwarf mistletoe parasitism on lodgepole pine volume yields; and
3. The changes in dwarf mistletoe incidence and intensity over time as a result of the thinning.

The next recording of plot data is scheduled for 1993. However, the plot area is currently jeopardized with destruction from the North Fork fire in Yellowstone National Park. (J. Hoffman, USFS, Region 4).

5.6 15-year records were taken on permanent plots established to measure tree growth and mistletoe responses in thinned Douglas-fir pole stands in Eastern Oregon and Washington. In addition, a new study in sapling Douglas-fir sapling stands was begun on the Okanogan National Forest. The results will be prepared for publication this winter.

R. Tinnin, Portland State University.

6. ECOLOGY

- No reports.

7. CONTROL-CHEMICAL

7.1 A number of tests with the ethylene-releasing agent Ethephon were conducted on various mistletoes in the west this year. See details elsewhere in these proceedings for the papers from the Ethephon Panel.

- 7.2 A cooperative test of the effectiveness of the plant growth regulator Ethephon against western dwarf mistletoe on ponderosa pine was conducted by C. Parks of the USFA FS Forestry and Range Sciences Laboratory in LaGrande, Oregon and J. Hoffman of the USDA FS Intermountain Region. (J. Hoffman, USFS, Region 4).

8. CONTROL-BIOLOGICAL

- 8.1 The mistletoe rust, Peridermium bethelii, was found to be commonly associated with lodgepole pine dwarf mistletoe in one area of the Fraser Experimental Forest, Colorado. In a 30-year old stand, we examined 63 trees and 92% of them had mistletoe and 55% of the mistletoed trees had rust. Six trees had recently been killed by girdling rust cankers and 40% of the live trees had rust associated-mistletoe bole infections so they can be expected to kill these trees as well. Thus, the mistletoe rust may be a more important factor associated with mortality of young mistletoe-infected lodgepole pines than we previously realized. (F. Hawksworth, USFS, RM Station; T. Nicholls, USFS, NC Station).

9. CONTROL-SILVICULTURAL

- 9.1 Plans are to treat 3,573 acres of dwarf mistletoe-infected stands on the Arapaho and Roosevelt; Grand Mesa, Umcompahgre and Gunnison; Medicine Bow; Pike and San Isabel; Routt; Shoshone; and White River National Forests. (D. Johnson, Rocky Mtn. Region).
- 9.2 Dwarf mistletoe suppression projects were funded and scheduled over nearly 4,000 acres on 13 National Forests in the southern Idaho, western Wyoming, Utah, and Nevada during 1988. (J. Hoffman, USFS, Region 4).

10. SURVEYS

- 10.1 Stem analysis data from 100 lodgepole pine trees infected by lodgepole pine dwarf mistletoe near Prince George, British Columbia were analyzed to determine the effects of infection on tree form. Volumes for sections and whole tree lengths were compared using Smalian's formula and the B.C. Ministry of Forests volume equation. There were no apparent trends or differences when the ratios were plotted for each five year tree growth increment. Therefore, we have tentatively concluded that dwarf mistletoe infection had no effect on tree form.

We plan to undertake some further stem analyses to check this preliminary conclusion, and to do some further sampling to determine the effect of tree density (stems per hectare) and mistletoe infection on tree volume growth. (J. Muir, B.C. Forest Service, Victoria and A. Thomson, Pacific Forestry Centre, Victoria).

- 10.2 Pre-suppression surveys are planned for 14,791 acres on Arapaho and Roosevelt; Medicine Bow; Pike and San Isabel; and White River National Forests. (D. Johnson, Rocky Mountain Region).

Disease Control Committee 1988 Investigations

Kenelm Russell, Chairman

Washington Wild Edible Mushroom Legislation

Pending legislation regulating harvesting of wild edible fungi was passed in 1988 making Washington the first state to regulate this edible forest crop.

The new law requires annual licenses of \$75 for wild mushroom buyers and \$375 for wild mushroom processors. Licensees must report annual production, species, and general harvest location to the Washington State Department of Agriculture. The data will be published with other agricultural commodities. Pickers, either commercial or recreational, are not licensed and have no daily bag limit. Originally, a portion of funds collected were to be earmarked for research on mushroom crop production, but it was deleted by amendment.

The action began in 1985 when several bills were introduced in the Washington legislature regulating everything from daily mushroom bag limits for pickers to licensing the processors--none of which succeeded. After long task force discussions, the lone bill passed. Continued legislation is pending in the 1989 legislature.

The Washington Department of Natural Resources has the challenge of devising a plan for marketing wild edible mushrooms from state lands. The system has to be simple and economical to administer. Since mushrooms have become a valuable forest commodity, the department is bound by law to sell them. Recreational pickers, however, can still pick mushrooms from state lands without charge.

The 1988 fall mushroom season was excellent, particularly for matsutake (*Armillaria ponderosa*). These mushrooms can retail for as much as \$90 per pound. One person in Washington remembers seeing a pick-up truck loaded to the top with these valuable mushrooms. British Columbia is reported to have exported 214 metric tons to Japan with a value of some \$13,000,000. That ain't hay!

Two publications are available by writing to me: "Wild Edible Mushroom Issues" and "Russell, K.W. 1987. What we need to know about harvesting commercial mushrooms." *McIlvania* (Jour. of American Amateur Mycology) Vol 8, No. 1.

British Columbia is currently deciding whether they want mushroom harvest regulations.

Forest Health

The USDA Forest Service publication, "Forest health through silviculture and integrated pest management: a strategic plan" was published in early 1988 and was discussed at Park City. As outgoing chair of the Forest Pest Committee for the Western Forestry and Conservation Association, I proposed to Executive, Richard Zabel that the committee be changed to Forest Health which the WF&CA trustees did. Likewise, I have made a change in our own Forest Pest Management Program in the Department of Natural Resources. You guessed it-- we are now the Forest Health Section.

The new name promotes healthy forest management and helps sell the idea of dealing with potential forest pest problems long before they become problems. The new name also lets us take a broader look at the health of the forest. We can do a better job of bringing "health care for trees" into forest management planning.

Changing the Guard

Back in 1967, Alex Molnar, Santa Fe meeting WIFDWC chair asked if I would head a new Disease Control Committee. I've been at it ever since except for a year when Larry Weir did it. Quoting in part from the Santa Fe Proceedings, the committee was, "charged with annually presenting to WIFDWC the results of all forest disease control tests conducted by the membership. Tests would be reported in three categories: chemical, biological, and silvicultural."

"Operation of the committee would be similar to the Dwarf Mistletoe Committee, but would not report results of that committee."

"Committee chair term would be for two years." (My term became extended because I re-upped each two years.)

Time for change! By unanimous vote, Bob James will become the new helm.

Summary of Luncheon Discussion in Park City

Seventeen of us met at lunch for in-depth discussion on where we are going with modern forest pest management.

We zeroed in on long term forest health. There was a general consensus that true long term forest health planning by foresters is still insufficient. There is much more that needs to be done to thoroughly integrate pest management into the forest management process. The pest management disciplines need to go more in the direction of silviculture/ecology than to the pure FPM discipline simply because there are more of "them" than "us." We need to work constantly at getting involved in silviculture programs.

A major selling point for aggressive IPM is that if a pest problem is fairly intense and could be economically reduced, the gain in volume or survival could be several times that of standard silviculture treatments. We agreed that the Forest Health publication put together by the USDA Forest Service provides an excellent base for embarking on an IPM-silviculture oriented path.

Pest managers must be constantly reminded that their main client is the land manager. They must work hard to get land managers to subscribe to IPM practices routinely. The constant sales pitch for IPM must not let up.

Another issue that came up is all aged management. Chances are good that more of this will be done in the future. What kind of pest management information do we have that will apply to all aged management? Do we need to embark on new research to develop special technology? Are pest managers able to meet the social desires of these changing times? Are the drivers in FPM paying attention to the changes, then making them?

We raised questions about western white pine management. The basic question was, "Where can we grow white pine in the West?" Foresters in the heart of the white pine range in the Inland Empire of Idaho are still reluctant to plant even improved stock because of the lack of operational guides for evaluating risk of blister rust infection. This concern needs to be addressed by someone who can look at the entire West and come up with rust hazard recommendations foresters could depend on. It is not generally known by foresters that if they manage white pines some distance away from Ribes plants, the chances for infection diminish significantly. What are the distances and how much does the risk drop?

Note: Be sure to check out the "Proceedings of a western white pine management symposium," jointly sponsored by Westar Timber, BC Ministry of Forests, and the Canadian Forestry Service. The symposium was held at Nakusp, B.C. in May, 1988. The proceedings is a gem- a must for finding good information about white pine.

It is my hope that management guides using the latest technology will be published on white pine.

We agreed that in order to educate and push for continued IPM awareness, we need more good IPM demonstration areas. Good installations should be replicated throughout the regions. This charge is aimed at all forest pathologists. Get out there and set up your IPM demo areas!

Lastly, what can we glean from presence of root rots in progeny sites? Are certain tree families more susceptible to root rots than others?

1988 Forest Disease Control Tests

Listed on the following pages are disease control projects for this year. The list is not complete:

SEEDLING DISEASES--NURSERIES

1. Damping-Off

Host: Conifer Seedlings, DF, PP, JP

Causal Organism(s): Fusarium, Pythium, Macrophomina

Control: Chemical

Development Stage: Pilot Operational

Put in operational plot testing efficacy of basamid (Dazomet) granular at the Placerville Nursery, CA. results available in fall 1989.

(S. Frankel FPM, Region 5, USDA Forest Service)

2. Fusarium Root Disease

Host: Conifer Seedlings, DF (Containers)

Causal Organism(s): Fusarium spp

Control: Chemical

Development Stage: Pilot Operational

Test to evaluate efficacy of granular Banrot to control root disease of containerized seedlings.

(R. James, FPM, Region 1, USDA Forest Service, R Dumroese, D. Wenny, U of Idaho)

3. Conifer Seedling Root Disease

Host: All local conifers

Causal Organism(s): Fusarium, Phytophthora, and Pythium spp

Control: Chemical

Development Stage: Pilot Operational/Field Trial

Evaluate efficacy of Basamid in reducing seedling mortality and cull rate.

(J. Hoffman and R. Williams FPM, Region 4, USDA Forest Service, Boise)

DWARF MISTLETOES

1. Western Dwarf Mistletoe

Host: Jeffrey pine, Lodgepole pine

Causal Organism(s): Arceuthobium campylopodum

Control: Chemical

Development Stage: Field trial

Ethephon sprayed at 2500 ppm for control of spread of DM in various hosts. State demonstration forest with CDF assistance.

(S. Frankel FPM Region 5, USDA Forest Service)

2. Douglas-fir Dwarf Mistletoe

Host: Douglas-fir

Causal Organism(s): Arceuthobium douglasii

Control: Chemical

Development Stage: Field trial

Sprayed DM brooms with Ethrel- will test remaining DM seed for germination.

(C. Parks, PNW lab, La Grande, OR. USDA Forest Service)

3. Lodgepole pine Dwarf Mistletoe

Host: Lodgepole pine

Causal Organism(s): Arceuthobium americanum

Control: Silvicultural

Development Stage: Demonstration

Evaluate different thinning regimes for 1, growth and yield in LPP stands and 2, spread and intensification of DM.

(J. Hoffman Region 4, Boise, USDA Forest Service)

4. Lodgepole pine Dwarf Mistletoe

Host: Lodgepole pine

Causal Organism(s): Arceuthobium americanum

Control: Chemical/Silvicultural

Development Stage: Full Operational Field trial

Aerial Ethephon applications failed to cause shoot abscission. Intensive/extensive silvicultural control measures are actively applied in our region. A specific forester position is responsible for DM control operations.

(Manitoba Dept of Natural Resources-Forestry Board/U of Manitoba, Dept of Botany)

5. Southwestern Dwarf Mistletoe

Host: Ponderosa pine

Causal Organism(s): Arceuthobium vaginatum sub sp. cryptopodum

Control: Chemical

Development Stage: Pilot Operational

Ethephon (Florel Pro Brand) was applied to ponderosa pine DM at 0, 220, and 2700 ppm. Applications made in mid June, mid July and mid August. Results available winter 88-89.

(D. Johnson, F. Hawksworth FPM Region 2 & RMFRES, Fort Collins)

6. Western Dwarf Mistletoe

Host: Jeffrey pine

Causal Organism(s): Arceuthobium campylopodum

Control: Silvicultural

Development Stage: Full Operational

Treatment of Jeffrey Pine in several Lake Tahoe recreation areas to control DM used both tree removal and pruning.

(G. DeNitto, T. Hintz, FPM Region 5, USDA Forest Service)

7. Dwarf Mistletoe

Host: LP PP

Causal Organism(s): Arceuthobium campylopodum and americanum

Control: Silvicultural

Development Stage: Full Operational

Good progress is being made in using proper regeneration techniques to avoid a DM problem. On many Utah and Wyoming forests, residual removal is working.

(L. Lamadeliene, FPM Region 4, USDA Forest Service)

ROOT DISEASES

1. Black Stain Root Disease

Host: DF

Causal Organism(s): Leptographium wagneri

Control: Silvicultural/Genetic

Development Stage: Field trial/Greenhouse

a. A study of stand-site factors associated with black-stain indicates that several factors, ie disturbances, stocking, composition, elevation, aspect, and slope position can be used to risk rate.

b. Inoculation of DF seedlings from 11 seed sources in CA indicate that there may be a usable differential in resistance to L. Wagneri

(F Cobb, UC Berkeley)

2. Annosus Root Disease

Host: PP

Causal Organism(s): Heterobasidion annosum

Control: Chemical/Biological

Development Stage: Field Trial

Evaluating need for treatment & efficacy of various treatments (Borax, timing of thinning, duff, high stumps) to prevent annosus establishment in thinned second growth pp stands.

(R. Williams FPM, Region 4, USDA Forest Service, Boise)

Rust Committee Report
prepared by Brian W. Geils

The following members attended:

D. French, W. Jacobi, F. Cobb, J. Allison, J. Hoffman, J. Pronos, D. Volger,
J. Boyd, and B. Geils.

The main topic of discussion was a proposal to promote cooperative studies on stem rust biology and management by establishing a more formal group which would include researchers working on fusiform rust. Fields Cobb volunteered to contact Walt Kelly (Auburn University) regarding a joint meeting of western Canadian and US rust researchers with members of the CSRS coordinating committee for fusiform rust. The IUFRO stem rust committee meeting next year in Banff could provide an opportunity for us to form an active working group which might have annual meetings and plan cooperative studies.

- 120 -
ROOT DISEASE COMMITTEE REPORT
ROOT DISEASE RESEARCH NEEDS IN WESTERN NORTH AMERICA

Gregory M. Filip
Chairman, Root Disease Committee

At the request of Dick Smith, Washington Office Research Pathology Staff, I solicited a list of root disease research needs from 25 units with forest pathology staffs in western USA and Canada. The following sixteen (64%) units responded:

Forest Pest Management, USDA:	Oregon State Dept. Forestry (OSDF)
Region 1, Missoula	Idaho Dept. of Lands (IDL)
Region 2, Lakewood	BC Ministry of Forests and Lands (BCF)
Region 3, Albuquerque	Oregon State University (OSU)
Region 4, Boise	Utah State University (USU)
Region 5, San Francisco	No. Forestry Centre, Alberta (NFC)
Region 6, Portland	Pacific Northwest Research Station (PNW)
Region 10, Juneau	Pacific Southwest Research Station (PSW)
	Intermountain Research Station (INT)

Almost all research needs addressed problems concerning root diseases caused by Armillaria spp., Heterobasidion annosum, and Leptographium wageneri. All northern units (north of California) expressed needs involving Phellinus weirii. Some units expressed needs to do research concerning Inonotus tomentosus (R-3, R-4, R-10, NFC, BCF), Phaeolus schweinitzii (R-10), and Phytophthora lateralis (R-5). Some units expressed needs to work with root pathogen complexes (R-1, R-6, IDL).

There were seven broad areas that covered most of the expressed research needs (not listed in order of importance):

- (1) **Site Ecology.** Effects of site or stand variables (slope, elevation, habitat type, soil type, disturbance history, etc.) on disease incidence and severity; risk rating systems and loss forecasting
- (2) **Resistance/Vigor.** Determination of susceptibility within and among tree species; relations between tree vigor and disease severity
- (3) **Survey Methods/Impact Assessment.** Development of sampling systems to determine disease incidence and impact; development of accurate economic analyses of root disease control programs
- (4) **Management/Control.** Effects of various practices (thinning, stumping, burning, resistant species, fertilizing, regen methods, etc.) on disease incidence and severity
- (5) **Armillaria Taxonomy.** Identification and pathogenicity of biological species within the Armillaria complex

GREGORY M. FILIP is a research plant pathologist at the Pacific Northwest Research Station, USDA Forest Service, Forestry and Range Sciences Laboratory, La Grande, Oregon.

(6) **Model Refinement.** Improvement of the existing root disease submodel; extension to include other geographical areas and other pathogens

(7) **Pathogen Biology/Disease Etiology.** Study pathogen epidemiology and survival; study relations among root pathogens and other organisms (fungi, insects, mammals)

These seven research needs were expressed by the following units:

<u>Site Ecology</u>	<u>Vigor/Resistance</u>	<u>Survey/Impact</u>	<u>Control/Management</u>	<u>Armillaria Taxonomy</u>	<u>Models</u>	<u>Biology/Etiology</u>
R-1	R-1	R-3	R-1	R-2	R-2	R-1
R-2	R-2	R-4	R-2	R-3	R-3	R-5
R-4	R-3	R-5	R-3	R-5	R-4	R-6
R-5	R-6	R-6	R-4	R-6	R-6	R-10
R-6	BCF	BCF	R-5	IDL	OSDF	BCF
R-10	OSDF	OSU	R-6	INT	IDL	IDL
BCF	INT	USU	BCF	PNW	PNW	INT
IDL	PNW		OSDF	NFC		PNW
INT	OSU		IDL			PSW
PNW			PNW			OSU
PSW			USU			
OSU						

A spirited discussion among the committee members followed the presentation of this material. It was suggested that the list of seven root disease research needs be circulated among forest managers in western North America. Forest managers would be asked to prioritize the list and add research needs they feel should be included in the list.

- 122 -
BUSINESS MEETING MINUTES

The meeting was called to order on September 23, 1988 by Chairman Jim Byler.

It was reported that two of our members passed away during the year: Phil Thomas, a charter member, and Clarence Quick. Chairman Byler asked for a moment of silence.

A letter and check had been received from Harold Offord who could not attend. Ken Russell informed the Conference that Harold does this every year to show his support. There was a motion to have the Secretary prepare and send a letter of appreciation to Harold. The motion passed unanimously.

Thanks were expressed to the following people for a successful conference: Fred Baker and others from Utah for local arrangements; John Pronos for organizing the program; Gregg DeNitto for last year's Proceedings; and Frank Hawksworth, Jerry Beatty, Fred Baker, and Borys Tkacz for the pre-WIFDWC field trip.

OLD BUSINESS

Last year's meeting minutes were accepted as presented in the Proceedings.

Committee Reports

The Disease Control Committee elected Bob James as their new chairman. The Rust Committee is going to become more integrated with the Southern Rust Committee.

The Root Disease Committee discussed research needs and priorities. Written committee reports appear elsewhere in these Proceedings.

Treasurer's Report

The balance as of 9/1/88 in the Washington State Employee's Credit Union was \$836. A detailed report is elsewhere in the Proceedings. The report was accepted as presented.

The 37th meeting will be held at the Inn of the 7th Mountain in Bend, OR from September 11 to 15, 1989. This will be a joint meeting with the Western Forest Insect Work Conference. The chairman had appointed Don Goheen as an interim Program Chair to begin work with the entomologists prior to this meeting. A committee of pathologists and entomologists will be created soon to formulate next year's program.

SAF continuing education credits were discussed. Because of the local nature of acquiring these credits, it was decided that the Local Arrangements Chairperson should be responsible for their acquisition. Meeting announcements should include a statement that credit is being sought.

NEW BUSINESS

The need to reprint Common Names of Western Forest Diseases was discussed. Hal Burdsall, Forest Products Lab, is compiling a national list. It was decided to incorporate the western list with the national list and to evaluate the product.

Meeting Location - 1990

Four locations were offered as potential sites

- 1) Riverside, CA
- 2) Redding, CA
- 3) Grant Grove, CA - Sequoia National Park
- 4) Colorado

Redding, CA was selected. Region 5, FPM, Northern California Service Area will be the host.

John Laut made a motion to explore meeting locations 3 years in advance because of difficulties in site reservations. The motion carried and will be initiated at the 1989 meeting.

John Schwandt suggested that pre- and post-WIFDWC field trips be included as part of the official meeting agenda to allow individuals to get approvals to attend and, thereby, reduce airfare costs. It was also suggested that the organizing committee take into account dates and locations of the meeting and field trips to limit airfare costs. Other local organizations should be contacted about the meeting to encourage attendance.

Mo-mei Chen, UC Berkeley, formally invited all members of the Conference to the IUFRO Workshop on Protection and Management of Mountain Forests to be held October 11-20, 1989 in Chengdu, PRC.

Ad Hoc Committee

There was a motion from John Laut to establish an ad hoc committee to develop a public involvement activity plan to be presented for consideration of the membership at the 37th meeting in Bend, OR in 1989. The committee shall act in concert with a similar committee of the WFIWC. The motion carried. The new WIFDWC chairperson shall appoint committee members.

There was a motion from John Muir that where an author is unavailable to give permission for citation of a paper from WIFDWC Proceedings, that the author's organization may grant permission. Discussion of the motion revealed that the subject had previously been discussed and it had been determined that existing laws do not allow us to restrict citation because the information is in the public domain. The motion was dropped.

Election of Officers

Dick Parmeter served as spokesperson for the Nominating Committee. The following individuals were nominated, ran unopposed, and were unanimously elected as the 1989 officers.

Chairman - Don Goheen

Secretary/Treasurer - Bob James

A motion was made and carried to thank Jim Byler for his efforts as Chairman in providing an enjoyable and productive Work Conference.

Chairman Byler adjourned the Conference.

Respectfully submitted for Bart van der Kamp by Gregg DeNitto

WIFDWC FIELD TRIP
September 22, 1988

The caravan departed from the Resort Center Lodge almost on schedule at 9:08 am. Leon LaMadeleine, USFS, Ogden, UT, led the parade. He immediately demonstrated his easterner prowess by making a U-turn in the middle of an intersection after quickly realizing he was leading us in the direction opposite to what was desired.

The first stop was at Bridal Veil Falls which claims to have the world's steepest tram. Unfortunately, the tram was not scheduled to operate because of the damp weather. Again, Leon came to the rescue and through peaceful coercion got the proprietor to start the tram and carry loads of pathologists to the top of the mountain. Not a single pathologist was lost.

From the Falls, the group headed onto the Uinta National Forest and around Mt. Timpanogos. The importance of the hardwood component as a visual resource was evident as the fall coloration was at its peak.

Lunch was at Granite Flat Campground up the American Fork Canyon. Excellent lunches were available and consumed.

Steve Winslow, District Recreation Forester, Pleasant Grove Ranger District, Uinta National Forest, presented information on the recreation resource on the District and in the American Fork Canyon. This led into a discussion of some of the concerns and problems with the vegetation and the visual effects in the canyon.

The group then travelled down the canyon, observing the condition of the vegetation. Near the mouth of the canyon, the worst conditions were viewed. Numerous cottonwoods were dead or dying. Several canker fungi were implicated, along with several possible abiotic stress factors.

Following this stop, one large subgroup travelled back to Timpanogos Cave National Monument. After considerable deliberation in the lobby as to whether we could get to the cave and back to Park City in time for the banquet, two groups charged up the trail. Following a 1-1/2 mile hike with a 1000 foot climb, the cave was a wonder to see. All who went thought it was worth the effort. Fields Cobb, "head" spelunker, was so taken aback, he left part of himself in the cave. For his effort he received the Golden Stalagmite award and was crowned as WIFDWC's first recipient.

Treasurer's Report, 36th WIFDWC

Balance on hand at close of thirty-fourth meeting.	(\$U.S.)	1073.91
Adjustment for 1987 (35th) proceedings cost (Original estimate was \$750.00; actual cost was \$1072.14)		(322.14)
Inn of the Seventh Mountain meeting deposit for 1989		(250.00)
Interest paid July 1, 1987 through June 30, 1988		60.67
Miscellaneous proceedings sales (34) from 1/1/88 to 12/31/88		219.00
Special contribution from Harold Offord		25.00
Deposit from Nanaimo meeting (check that had been misplaced)		79.60
Deposits from Park City meeting		2409.50
Paid out for Park City meeting		(1824.97)
Note: The amount deposited and paid out from the Park City meeting is only part of the total bill. The balance was paid directly by local arrangements.		
Sub-total		1470.57

Thirty-sixth WIFDWC statement from Park City meeting

Receipts:

Regular participants	57	
Students	6	
Spouses	11	
Total registration	74	\$4611.50
Sale of open liquor		35.16

Sub-total 4646.66*

Expenses:

Master Hotel Bill	3994.31	
Balance of meeting deposit due USU	250.00	(250.00)
Hospitality Room	78.00	
Proceedings printing estimate	1300.00	(1300.00)

Sub total: 5622.31*

Balance at close of thirty-sixth meeting (79.43)

* Rainy day note: For years our credit union revolving account balance has averaged about \$1000 in case of emergency need. This year, due to advanced purchase of lunches not eaten, and higher than estimated proceedings printing costs, the Park City meeting lost \$975.65 (4646.66-5622.31) which we can absorb. The account interest from July 1, 1988 through June 30, 1989, proceedings sales during 1989, and careful control of cash flow will put the negative balance shown above (79.43) in the black. Adjustments will be posted in the 1989 financial report.

Account 936258, Washington State Employee's Credit Union. PO Box WSECU, Olympia, WA 98507. Phone (206) 943-7911. Official signatures for withdrawing funds are Walt Thies, Ken Russell and Fields Cobb.

Ken Russell, Treasurer, February 7, 1989.

WIFDWC PROJECTS

A. Forest Disease Surveys - General

- 71-A-4 Appraisal of damage caused by forest pests in British Columbia (R. Alfaro).
- 71-A-5 Forest insect and disease survey (G.A. Van Sickle).
- 71-A-7 Forest insect and disease survey in the prairie Provinces, and Northwest Territories (Y. Hiratsuka, H. Wong, H. Cerezke, B. Moody).
- 73-A-4 Forest disease: diagnostic and taxonomic services and research (A. Funk).
- 74-A-1 Disease (and insect) detection surveys in Colorado forests (J. Laut, M. Schomaker).
- 81-A-6 Mortality of *Chamaecyparis nootkatensis* in southeast Alaska (T. Shaw, P. Hennon).
- 82-A-3 Disease and insect impact on young growth, mixed conifer stands in California (J. Pronos, L. Dolph).
- 84-A-1 Pest Impact Assessment Methodology-*Fomes annosus* (J. Parmeter, G. Slaughter W. Otrosina).
- 85-A-1 Evaluation of seed tree mortality on the Powell Ranger District, Clearwater National Forest, Idaho (C. Stewart).
- 85-A-2 Disease Sampling in Douglas-fir plantations (W. J. Bloomberg).
- 85-A-4 Pathological aspects in the management of Alaska-cedar for timber production (P. Hennon).
- 85-A-5 Survey to describe the extent and impact of major root disease on non-federal timberlands in Oregon (A. Kanaskie).
- 85-A-6 Estimating extent and distribution of black stain root disease on state lands in Oregon (A. Kanaskie).
- 86-A-1 Black stain root disease survey, Oregon and Washington (W. Litke)
- 86-A-2 Surveys of pest incidence and damage in young plantations (J. Muir).
- 87-A-1 Assessing stand root disease mortality using ground and aerial rating systems (S. Hagle).
- 88-A-1 Evaluation of aspen sprout mortality (D.Hildebrand, W.Jacobi)

B. Non-Infectious diseases

- 80-B-2 Trend of ozone injury to conifers in the southern Sierra Nevada (J. Pronos).
- 86-B-1 Ozone in Puget Sound forests (R. Edmonds).
- 86-B-2 Acid fog in the Cascades (R. Edmonds).

C. Cone, Seed, and Seedling Diseases

- 76-C-1 Diseases of seeds and cones- PC-54-07 (J. Sutherland).
- 83-C-2 Assessment of new chemicals to control *Botrytis* blight in nurseries (R. James).
- 83-C-3 Fungi associated with pine seedlings tip blight in Northern Rocky Mountain nurseries (R. James).
- 84-C-1 The effect of inoculum density of *Macrophomina phaseolina* on conifer nursery production (A. McCain).

- 84-C-3 Studies of Fusarium-associated diseases of conifer seedlings at northern Rocky Mountain nurseries (James, Gilligan, Dumroese).
- 85-C-8 Biological and chemical control of soil-borne fungi in forest tree nurseries (R. Blanchette).
- 85-C-16 Interactions between cover crops, fumigation, nitrogen availability and soil-borne pathogens in nurseries (E. Hansen)
- 86-C-6 Impact of seed-borne pathogens on seedling performance (W. Littke).
- 86-C-7 Cone and seed treatments to increase seed extractability, quality, and performance (W. Littke).
- 86-C-8 Impact of Fusarium and other pathogens during cold storage on seedling quality (W. Littke).
- 86-C-9 Measurement of Fusarium populations over entire crop cycle (W. Littke)
- 87-C-1 Biological control of Fusarium oxysporum (E. Hansen, P. Hamm).
- 87-C-2 Soil pest assay of the Basamid trial at the Lucky Peak Forest Nursery, Idaho (J. Hoffman).
- 87-C-3 Effects of seedling root colonization by Fusarium on Douglas-fir Outplanting survival (R. James, Dumroese).
- 87-C-4 Pathogenicity of Fusarium spp. on conifer seedlings (R. James, Dumroese).
- 87-C-5 Evaluation of Basamid granular to control root diseases in Northern Rocky Mountain nurseries (R. James, Myers).
- 87-C-7 Relationship between soil propagule counts of Fusarium and Pythium to 1-0 seedling disease (A. Kanaskie, P. Hamm, S. Cooley).
- 87-C-8 Evaluation of incorporation and sealing methods with Dazomet application at J. Herbert Stone Nursery (S. Cooley, B. Kelpsas).
- 88-C-1 Dazomet study. Trial evaluating the efficacy of Dazomet in controlling Fusarium, Pythium, Macrophomina, and weeds at the Placerville, USFS nursery (S. Frankel)
- 88-C-2 Epidemiology of Fusarium-associated diseases on containerized conifer seedlings (R. James, D. Dumroese, D. Wenny, C. Gilligan)
- 88-C-3 Efficacy of granular Banrot^R to control root diseases of containerized conifer seedlings. (R. James, K. Dumroese, D. Wenny, C. Gilligan)
- 88-C-4 Efficacy of sodium metabisulphite in reducing root disease inoculum on seedling containers. (R. James, K. Dumroese, D. Wenny, C. Gilligan)
- 88-C-5 Cylindrocarpus: pathogenicity to conifer seedlings and control tests. (R. James, K. Dumroese, D. Wenny, C. Gilligan)
- 88-C-6 Evaluation of the effectiveness of Dazomet (Basamid^R) to control root diseases at the USDA Forest Service Nursery, Coeur d'Alene ID (R. James, J. Myers, C. Gilligan)
- 88-C-7 Conifer seed treatment: effect on germination and pathogen populations. (K. Dumroese, R. James, D. Wenny)

D. Root and Soil Diseases or Relationships (including Mycorrhizae)

- 71-D-3 Relative species susceptibility to Phellinus weirii infection (E. Nelson).
- 71-D-2 Phellinus weirii root rot: epidemiology and control (W. J. Bloomberg).
- 71-D-3 Fomes annosus root and butt rot: epidemiology and control (D. Morrison).
- 71-D-4 Effects of nitrogen fertilization and interplanting red alder on root disease development in a thinned Douglas-fir plantation (E. Nelson).
- 73-D-3 Alnus rubra as a biological control agent for Phellinus weirii (E. Hansen, E. Nelson).
- 76-D-4 Simulation of root rot impact in second-growth coastal Douglas-fir stands (W. Bloomberg).
- 79-D-1 Surveys of root diseases in managed conifer stands in R-2 (D. Johnson, E. Sharon).

- 79-D-5 Spread of *Armillaria* spp. disease centers in managed pine stands (D. Johnson, E. Sharon).
- 79-D-9 Evaluation of effects of precommercial thinning in 10- to 20-year-old Douglas-fir plantations infected with *Armillaria* root rot in Oregon and Washington (G. Filip).
- 79-D-17 Evaluation of the incidence and impact of *Fomes annosus* in California fir stands (G. Slaughter, J. Parmeter).
- 79-D-18 Evaluation of borax stump treatment for control of *Fomes annosus* in California fir stands (M. Shultz, G. Slaughter, J. Parmeter).
- 79-D-23 Susceptibility of Pacific Northwest conifers to laminated root rot (W. Thies, E. Nelson).
- 79-D-25 Spatial relations of tree species in root disease areas (N. Martin).
- 80-D-2 Epidemiology and management of black stain root disease of western North American Conifers (F. Cobb).
- 80-D-5 Evaluation of effects of precommercial thinning in 10- to 20-year-old red fir plantations infected with *Armillaria* root rot in southern Oregon (G. Filip).
- 81-D-21 Role of mycorrhizae in plant succession in the Mount St. Helens devastation zone (J. Trappe).
- 82-D-4 Demonstration of *Armillaria* root disease control methods (S. Hagle, R. Becker).
- 82-D-5 Assessment of root disease development in young managed stands and plantations (J. Byler, R. James).
- 82-D-7 *Armillaria* root rot of young intensively managed lodgepole pine stands of Alberta (Y. Hiratsuka, P. Blenis).
- 83-D-5 Intensification of mortality from *Armillaria* following sanitation/salvage (S. Hagle, R. Becker).
- 83-D-7 Longevity and spread of annosus root disease in ponderosa pine plantations (J. Hoffman).
- 83-D-19 Mycorrhizal fungi associated with decayed logs in old-growth and young forests (J. Trappe).
- 85-D-4 Development of a method for rating stands of blue and Engelmann spruce in susceptibility to losses caused by *Inonotus tomentosus* root disease (F. Baker, B. Tkacz).
- 85-D-5 Incompatibility reactions, cytology, and population biology of *Phellinus weirii* and *Phytophthora* species (E. Hansen).
- 85-D-7 Epidemiology and management of *Fomes annosus* (*Heterobasidion annosum*) in western forests (F. Cobb).
- 85-D-10 Distribution of *Armillaria* genotypes in Pacific Northwest inland forest (N. Martin, G. I. McDonald).
- 85-D-11 Pathogenicity of *Armillaria* genotypes on native conifers of the Pacific Northwest inland forests (N. Martin).
- 85-D-15 Root distribution and infection by *Fomes annosus* in young mixed conifer and true fir stands (J. Parmeter, W. Otrosina, G. Slaughter).
- 85-D-22 Susceptibility of conifers (Grand fir, Englemann spruce, Douglas-fir, Western larch, and Ponderosa pine) to laminated root rot (A. Kanaskie).
- 85-D-24 Incidence of root pathogens in residual trees and stumps in thinned mixed conifer stands attacked by insects (G. Filip).
- 85-D-33 Hypogeous fungi of southwestern Oregon and northern California compared with those of Spain for nursery inoculation (J. Trappe).
- 86-D-1 Genetic variability in *Fomes annosus* (R. Edmonds).
- 86-D-2 *Fomes annosus* 20 years after precommercial thinning in hemlock (R. Edmonds).
- 86-D-3 Pathogenicity of *Armillaria* spp. on artificially defoliated grand fir seedlings (G. Filip).

- 86-D-4 Annosus root rot in the Northern Region (S. Hagle, et al.).
- 86-D-5 Site and tree risk factors in black stain root disease (E. Hansen).
- 86-D-6 Stump treatments to reduce black stain spread rate/vector attractiveness in high value stands (W. Littke).
- 86-D-7 Long-range effects of precommercial thinning on *Fomes annosus* in western hemlock stands (W. Littke)
- 86-D-8 Interactions of *Armillaria* and herbicides that are used to manage forest vegetation (N. Martin).
- 86-D-9 De-stumping trials for tomentosus root disease (J. Muir).
- 86-D-10 Evaluation of root removal by mechanical de-stumping in interior areas (J. Muir).
- 86-D-11 Evaluation of root diseases in interior backlog areas (G. A. Van Sickle, W. Bloomberg).
- 86-D-12 Problem analysis of root diseases in coastal backlog areas (G.A. Van Sickle, W. Bloomberg).
- 86-D-13 Survey of wood chips for pinewood nematode in British Columbia (J. Muir).
- 86-D-14 Lethal effects of chloropicrin on *Phellinus weirii* in culture tubes in stumps (E. Nelson).
- 86-D-15 Rate of damage by *Phellinus weirii* in Douglas-fir stands (E. Nelson).
- 86-D-16 Variability in *Verticicladiella wagneri* (W. Otrolina).
- 86-D-17 Monitoring root disease in thinned ponderosa pine plantations in northern Idaho (J. Schwandt).
- 86-D-18 Carbohydrate reserves and maintenance respirations: Controls of mycorrhizal turnover in ponderosa pine (R. Molina, J. Trappe).
- 86-D-19 Biological control of root diseases using *Trichoderma* spp. and other antagonists (E. Nelson)
- 87-D-1 Stump infection by *Fomes annosus* (S. Hagle).
- 87-D-2 Everything there is to learn about *Polyporus tomentosus* (E. Hansen, K. Lewis).
- 87-D-3 Tree stress and susceptibility to *Phellinus weirii* (E. Hansen, W. Thies, E. Goheen).
- 87-D-4 Adaptations of the root disease model to Region 3 (T. Shaw, J. Beatty).
- 87-D-5 Mycorrhiza-nodule interactions of native legumes (J. Trappe).
- 87-D-6 Mycorrhizal ecology of timberline and alpine zones of the North Cascades (J. Trappe).
- 88-D-1 Determination of optimal strategy for sampling for *Armillaria* root disease (F. Baker)
- 88-D-2 Colonization of lodgepole pine stumps by *Armillaria* (F. Baker).
- 88-D-3 Pathogenicity of *Armillaria* spp. on various tree species of New Mexico (W. Jacobi, T. Shaw, J. Beatty)
- 88-D-4 Occurrence of *Armillaria* root disease among families of coastal Douglas-fir in provenance test sites. (A. Kanaskie)
- 88-D-4 Distribution of *Phellinus* root disease as related to ecological classification (J. Beale, B. van der Kamp)
- 88-D-5 Species susceptibility, disease intensification, and loss prediction in an entered and unentered mixed-conifer stand infected by *Armillaria* in northeastern Oregon. (G. Philip, J. Colbert, C. Parks, P. Hessburg, T. Shaw)

E. Foliage Diseases

- 83-E-3 Swiss needle cast ecology and impact in northern Montana Christmas trees (S. Hagle).
- 86-E-1 Effect of fertilization and fungicides on Swiss needlecast (W. Littke).
- 86-E-3 Needlecasts of Scots pine Christmas trees in Montana (S. Hagle).

- 86-E-2 Role of Swiss neelecast in negative fertilizer interaction on coastal soils low in phosphorus (W. Littke).
- 87-E-1 Fungicide evaluation for controlling Marssonina leaf spot of aspen (W. Jacobi).
- 88-E-1 Variation in resistance and growth impact of *Melampsora* rust on western black cottonwood (B. van der Kamp, J. Wang)

F. Stem Diseases: Malformations, Witch's-Brooms, Dwarf Mistletoe, Etc.

- 62-F-4 Taxonomy, hosts, and distribution of *Arceuthobium* (F. Hawksworth, D. Wiens).
- 63-F-1 Spread and intensification of dwarf mistletoe in ponderosa and Jeffrey pines in California (R. Scharpf, J. Parmeter).
- 71-F-1 Growth impact, associated mortality, and spread and intensification of dwarf mistletoe in stands of Douglas-fir, and lodgepole pine (J. Byler).
- 76-F-4 Inoculation studies to determine the host ranges of *Arceuthobium campylopodum* and *A. occidentale* in California (W. Mark, R. Scharpf, F. Hawksworth).
- 78-F-2 Control of dwarf mistletoe-caused losses in young true fir stands by thinning (R. Smith, R. Scharpf, D. Vogler).
- 78-F-3 Population dynamics of dwarf mistletoe on true firs in California (R. Scharpf, J. Parmeter).
- 78-F-4 The effect of dwarf mistletoe on mortality and volume loss in released true fir stands (R. Scharpf).
- 78-F-5 Reduction of dwarf mistletoe-caused mortality of Jeffrey pines by broom pruning (R. Smith, R. Scharpf).
- 79-F-4 Dwarf mistletoe infection in inoculated young-growth western hemlock (T. Shaw, P. Hennon).
- 79-F-7 Growth loss in managed, even-aged, dwarf mistletoe-infested stands of ponderosa pine in the Pacific Northwest (E. Nelson, R. Harvey).
- 81-F-1 Resistance of Jeffrey pine to dwarf mistletoe, *Arceuthobium campylopodum* (R. Scharpf, B. Kinlock, J. Jenkinson).
- 81-F-4 Development of hemlock dwarf mistletoe following precommercial thinning of infected young stands in southeast Alaska (T. Shaw, P. Hennon).
- 82-F-4 Dwarf mistletoe-related mortality of ponderosa and Jeffrey pines in campgrounds in California (D. Vogler, R. Scharpf).
- 83-F-1 Thinning demonstration of dwarf mistletoe-infected lodgepole pine on the Targhee National Forest, Idaho (J. Hoffman).
- 83-F-5 Effect of N-fertilization on growth and development of dwarf mistletoe on red fir (R. F. Scharpf).
- 84-F-2 Field testing of dwarf mistletoe resistant Jeffrey pine seedlings (R. F. Scharpf, R. Smith).
- 85-F-2 The effect of dwarf mistletoe on the response of Douglas-fir to thinning (B. Tinnin, D. Knutson).
- 85-F-3 The effects of dwarf mistletoe on the response of young-Douglas-fir to thinning (B. Thinnin).
- 85-F-5 Silvicultural control of dwarf mistletoe in young lodgepole pine stands (D. Johnson, F. Hawksworth).
- 85-F-6 Dwarf mistletoe infection by seeds placed on western hemlock regeneration in coastal Alaska (T. Shaw).
- 85-F-7 Impact of *Arceuthobium americanum* in jack pine stands (F. Baker, D. French, K. Knowles).
- 85-F-8 Incidence of attack by dwarf mistletoe and western spruce budworm on Douglas-fir (G. Filip).
- 86-F-1 Evaluation of ethephon as a control of dwarf mistletoes in high use

- recreation forests (M. Robbins, F. Hawksworth, D. Johnson).
- 87-F-1 Dwarf mistletoe intensification and effects on growth and mortality of Douglas-fir in eastern Oregon and Washington (G. Filip, T. Shaw, J. Colbert, F. Hawksworth, P. Hessburg, M. Marsden).
 - 87-F-2 effects of ethephon on Douglas-fir dwarf mistletoe and western spruce budworm in northeastern Oregon (C. Parks, G. Filip).
 - 87-F-3 Intensification of Douglas-fir dwarf mistletoe in the Pacific Northwest (T. Shaw, F. Hawksworth).
 - 87-F-4 Intensification of Douglas-fir dwarf mistletoe in the Pacific Northwest (T. Shaw, G. Filip, F. Hawksworth).
 - 88-F-1 Ethephon evaluation. Trial evaluating the efficacy of Ethephon in controlling Western Dwarf Mistletoe in Ponderosa and/or Jeffrey pine. (S. Frankel)
 - 88-F-2 Effect of mistletoe broom removal on rate and distribution of bole increment in western hemlock (B. van der Kamp)
 - 88-F-3 Effects of ethephon on dwarf mistletoe of larch and ponderosa pine in northeastern Oregon and southwestern Idaho (C. Parks, J. Hoffman)

G. Stem Diseases: Stains and Decays

- 82-G-1 Bioactive metabolites of forest tree pathogens--*Gremmeniella abietina*, blue stain fungi associated with mountain pine beetle, *Condrostererum purpureum*, *Verticicladiella* spp. (Y. Hiratsuka, W. Ayer).
- 85-G-4 Sexuality, genetics, and biology of *Echinodontium tinctorium* (J. Rogers, D. Wilson, O.C. Maloy).
- 85-G-5 Effects of thinning on tree wound response in western conifers attacked by insects (G. Filip).
- 86-G-1 Interactions of pine bark beetles, their fungus associates, and their hosts (D. Wood, J. Parmeter).
- 88-G-1 Biological and management implications of fire/pathogen interactions in giant Sequoia.
- 88-G-2 Identification of and inoculation with stem decay fungi associated with bird-nesting cavities in western larch in northeastern Oregon (C. Parks, E. Bull, G. Filip, R. Gilbertson).

H. Stem Diseases: Rusts and Cankers

- 69-H-1 Thinning and pruning western white pine to control the blister rust disease (J. Byler, N. Martin).
- 71-H-3 Forest tree rusts of western North America (Y. Hiratsuka).
- 77-H-2 White pine blister rust pathology (R. Hunt).
- 81-H-1 Biology, cytology, and systematics of *Xylaria* (J. Rogers, B. Callan).
- 81-H-3 The etiology of *Thyronectria* canker on Colorado honeylocusts (W. Jacobi).
- 81-H-5 Biology and control of stem rusts of hard pines (R. Blanchette, D. French).
- 82-H-4 Western gull rust studies in relation to the genetic improvement program of lodgepole pine (Y. Hiratsuka, P. Blenis).
- 83-H-1 Hazard rating and ecology of comandra blister rust in the Rocky Mountain Region (W. Jacobi).
- 83-H-8 Distribution and parentage association of western gall rust infection in four ponderosa pine seed orchards (J. Hoffman).
- 85-H-1 Epidemiology and management of western conifer rusts (especially western gall rust and white pine blister rust) (F. Cobb).
- 85-H-8 Biology of limb rust on ponderosa pine (F. Baker).
- 85-H-9 Epidemiology of western gull rust (P. Blenis, Y. Hiratsuka).
- 85-H-10 Pathogenicity of *Cytospora* sp. on thin-leaf alder, dogwood, and hawthorn in

- eastern Oregon riparian zones (G. Filip).
- 86-H-2 Biological and economical feasibility of pruning and canker excision to control white pine blister rust (S. Hagle).
 - 86-H-3 Evaluating performance of blister rust resistant white pine stock in the coast range of Oregon (A. Kanaskie).
 - 87-H-1 Assessing the visual impact of limb rust in ponderosa pine (F. Baker).
 - 87-H-2 Blister rust incidence and impact in young sugar pine plantations, southern Sierra Nevada (G. DeNitto).
 - 87-H-3 Economics of intermediate stand treatments for white pine blister rust control (S. Hagle).
 - 87-H-4 Monograph of pine stem rusts (*Cronartium* and *Endocronartium*) (Y. Hiratsuka).
 - 87-H-5 Insects associated with comandra blister rust affected lodgepole pine (W. Jacobi, D. Leatherman).
 - 87-H-6 Model testing genetic interactions in western gall rust and Monterey pine (B. Kinloch, D. Vogler, W. Libby, F. Cobb).
 - 88-H-1 Evaluation of tree wound paint on pruning and mechanical wounds in a Douglas-fir seed orchard (A. Kanaskie)
 - 88-H-2 *Cytospora* canker of aspen: Predisposing stresses (W. Jacobi)
 - 88-H-3 Inheritance of resistance and pathogenicity in the lodgepole pine/western gall rust pathosystem (B. van der Kamp, H. Kojwang)
 - 88-H-3 Frost damage and canker pathogens associated with dieback of young Douglas-fir in central B.C. (R. Reich and B. van der Kamp)

I. Wilt and Blight Diseases

- 87-I-1 Pinewood nematode (J. Sutherland).

J. Defects and Decay of Forest Products

- 76-J-1 Microdistribution and efficacy of preservatives in treated wood and their effects on microorganisms (W. Wilcox).
- 87-J-1 Detection and evaluation of early stages of wood decay (W. Wilcox).

K. Miscellaneous Studies

- 73-K-3 Fungi of Washington State (J. Rogers).
- 78-K-1 Effect of thinnings on the incidence and impact of *Cytospora* canker, fir engraver beetle, and *Fomes annosus* in white fir stands on the east-side Sierra Nevada (G. Ferrell, R. Scharpf, J. Parmeter).
- 80-K-3 Interactions among the pinewood nematode, fungi, and bark beetles in the Midwest (R. Blanchette).
- 81-K-2 Life histories and anamorphs of lignicolous *Pyrenomycetes* (J. Rogers).
- 83-K-4 Mistletoe and root disease control demonstration areas (J. Muir).
- 84-K-1 Evaluation of pests associated with underburning mixed conifer stands for fuel reduction (J. Pronos).
- 85-K-1 Use of remote sensing techniques for detection, survey, and damage appraisal of root diseases (J. Y. Lee, W. J. Bloomberg).
- 85-K-2 Potential of *Beauveria bassiana* for direct control of bark beetles (H. S. Whitney).
- 85-K-3 Interactions among forest tree diseases, insects, hosts, and humans (F. Cobb).

- 85-K-6 Ultrastructure of wood decomposition by Basidiomycetes (R. Blanchette).
- 86-K-1 Biocontrol of forest weeds (C. Dorworth, R. E. Wall).
- 86-K-2 Field guide to forest pests in Montana and Idaho (S. Hagle, S. Tunnock).
- 86-K-2 Development of a Tree Health Mgmt. Series (THMS) for recreational, urban, and community forestry-multivolume slide/video tape (M. Sharon).
- 87-K-1 ELISA for detection of pathogenic fungi (E. Hansen, B. Fichter).
- 87-K-2 Tree diseases: host defense reactions (G. Jensen).
- 87-K-3 ARNEWS plots - Acid rain national early warning system (G. A. Van Sickle).
- 88-K-1 Survey to describe extent of Black bear damage to Douglas-fir stands in Northwest Oregon. (A. Kanaskie)

PUBLICATIONS: 1987-1988

Aho, P.E., G.M. Filip, and F.F. Lombard. 1987. Decay fungi and wounding in advanced grand and white fir regeneration. For. Sci. 33(2):347-355.

Baker, F. A.; D. Rabin. 1988. Using computer graphics to assess the visual impact of limb rust in ponderosa pine. Proc. 35th Annual Western Forest Disease Work Conference; 1987 August 18-21; Nanaimo, British Columbia, p. 16-20.

Chase, T.E. 1985. Genetics of sexuality and speciation in the fungal forest pathogen *Heterobasidion annosum*. Ph.D. Thesis, University of Vermont, Burlington. 244p.

Chase, T.E. and R.C. Ullrich. 1988. *Heterobasidion annosum*, Root- and butt-rot of trees. Adv. Plant Path. 6:501-510.

Chase, T.E., R.C. Ulrich, and K. Korhonen. 1985. Homothallic isolates of *Heterobasidion annosum*. Mycologia 77:975-977.

DeNitto, Gregg, Robert F. Scharpf and David Schultz. 1986 Biological evaluation of dwarf mistletoe in red fir advanced regeneration following overstory removal, Foster Meadows Timber Sale, Amador Ranger District, Eldorado National Forest. Report No. 86-20, Forest Pest Management, Pacific Southwest Region, U.S Forest Service, San Francisco, CA. 94111. 4p.

McCain, Arthur H., and Robert F. Scharpf. 1986 *Phytophthora* shoot blight and canker disease of *Abies* spp. Plant Disease 70:1036-1037

_____ & _____ Control of needle casts of white fir.

a) Bulletin of California Christmas Tree Growers No/ 130, p. 28, 1987

b) California Plant Pathology. Dec. No. 78, p 2-4, 1987

c) El Dorado Trees and Vines. U.C. Coop Extension Bulletin. P.7, June 30, 1988

Eav, B. B.; Marsden, M. A. 1988. Pest models for the inland mountain west. Proceedings-Future forests of the Mountain West: A stand culture symposium. W. C. Schmitt, Compiler, Missoula, MT, September 29- October 3, 1986. USDA Forest Service, General Technical Report INT-143: 141-144.

Eav, B. B.; Shaw, C. G. 1987. The western root disease model: A status report. Proc. 35th Annual Western Forest Disease Work Conference; 1987 August 18-21; Nanaimo, British Columbia. p. 84-92.

Filip, G.M. 1986. Symptom expression of root-diseased trees in mixed conifer stands in central Washington. West J. App. For. 1:46-48.

- Filip, G.M. and L.F. Roth. 1987. Seven chemicals fail to protect ponderose pine from *Armillaria* root disease in central Washington. Res. Note PNW-RN-460. Portland, OR: U.S Department of Agriculture, Forest Service, Pacific Northwest Research Station, 8p.
- Filip, G.M., C.A. Parks, K.W. Seidel, and F.F. Lombard. 1987. Incidence of decay fungi in stumps of two thinned western larch stands in northwestern Oregon. Res. Note PNW-RN-468. Portland, OR: USDA, Forest Service, Pacific Northwest Research Station. 5p.
- Filip, G.M. and C.A. Parks. 1987. Simultaneous infestation by dwarf mistletoe and western spruce budworm decreases growth of Douglas-fir in the Blue Mountains of Oregon. For. Sci. 33(3):767-773.
- Geils, B. W.; Jacobi, W. R. 1987. Comandra blister rust: a threat to lodgepole pine. In: Troendle, C. A., et al., eds. Management of subalpine forests: Building on 50 years of Research; Proceedings of a Technical Conference; 1987 July 6-9; Silver Creek, CO. USDA Forest Service Gen. Tech. Rep. RM-149: 216-217.
- Hawksworth, F. G. 1988. Mistletoes of Nevada. Northern Nevada Native Plant Society Newsletter 14(2): 3.
- Hawksworth, F. G.; Johnson, D. W.; Geils, B. W. 1987. Sanitation thinning in young, dwarf mistletoe-infested lodgepole pine stands. In: Troendle, C. A., et al., eds. Management of subalpine forests: Building on 50 years of Research; Proceedings of a Technical Conference; 1987 July 6-9; Silver Creek, CO. USDA Forest Service, Gen. Tech. Rep. RM-149: 218-219.
- Hawksworth, Frank G. and Robert Scharpf. 1987. Mistletoe literature of the world. In Parasitic Flowering Plants. Proceedings of the 4th International Symposium of Parasitic Flowering Plants. Ed. H.C. Weber and W. Forstreuter. Pjilipps Univ. Marburg, Germany. P.317.
- Hawksworth, F. G. 1987. Cacti as parasites? *Haustorium* 18:1.
- Hawksworth, F. G. 1987. Mistletoe and its lore. *The World and I* 2(12): 196-199.
- Hawksworth, F. G. 1987. Mistletoes of Colorado. *The Green Thumb*. Denver Botanic Gardens 44: 56-59.
- Hawksworth, F. G.; Nicholls, T. H.; Merrill, L. M. 1987. Long-distance dispersal of lodgepole pine dwarf mistletoe. In: Troendle, C. A., et al., eds. Management of subalpine forests: Building on 50 years of Research; Proceedings of a Technical Conference; 1987 July 6-9; Silver Creek, CO. USDA Forest Service, Gen. Tech. Rep. RM-149: 220-226.
- Hennon, P.; Shaw, C. G. III. 1988. Hemlock dwarf mistletoe demonstration area, Thorne Bay, Prince of Wales Island. USDA Forest Service, Alaska Region Leaflet R10-TP-5, 9 p.
- Hinds, T. E.; Shepperd, W. D. 1987. Aspen sucker damage and defect in Colorado clearcut areas. USDA Forest Service Research Paper RM-278, 12 p.

- Jacobi, W. R.; Boyd, J. E. 1988. Comandra Rust Risk-Rating Research. Proc. 35th Annual Western Forest Disease Work Conference; 1987 August 18-21; Nanaimo, British Columbia, p. 21-24.
- James, R. L. 1987. Occurrence of Fusarium on conifer tree seed from Northern Rocky Mountain nurseries. In: Landis, T. D. (tech. coord.) Proceedings: Combined Western Forest Nursery Council and Intermountain Nursery Association Meeting. USDA Forest Service, Rocky Mountain Forest and Range Exp. Sta., Gen. Tech. Rept. RM-137. pp.109-114.
- James, R. L., R. K. Dumroese, D. L. Wenny, J. F. Myers and C. J. Gilligan. 1987. Epidemiology of Fusarium on containerized Douglas-fir seedlings. 1. Seed and seedling infection, symptom production, and disease progression. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 87-13. 22p.
- James, R. L., J. W. Schwandt and J. Y. Woo. 1987. An evaluation of fungicides to control Diplodia tip blight at the Fantasy Farms Nursery, Peck, Idaho. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 87-10. 4p.
- James, R. L. 1988. Principles of fungicide usage in container tree seedling nurseries. Tree Planters' Notes 39(2):22-25.
- James, R. L. 1988. Root disease of containerized conifer seedlings-Western Forest Systems Nursery, Lewiston, Idaho. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 88-3. 5p.
- James, R. L. and C. J. Gilligan. 1988. Association of Fusarium with non-diseased containerized ponderosa pine seedlings at the USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 88-5. 10p.
- James, R. L. and C. J. Gilligan. 1988. Fungal colonization of styroblock containers-Plum Creek Nursery, Pablo, Montana. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 88-10. 9p.
- James, R. L. and C. J. Gilligan. 1988. Occurrence of Fusarium on Leach pine cells from the USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 88-8. 10p.
- James, R. L., C. J. Gilligan, R. K. Dumroese and D. L. Wenny. 1988. Microwave treatments to eradicate seedborne fungi on Douglas-fir seed. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 88-7. 8p.
- James, R. L., C. J. Gilligan and V. Reedy. 1988. Evaluation of root diseases of containerized conifer seedlings at the Champion Timberlands Nursery, Plains, Montana. USDA Forest Service, Northern Region, Timber, Cooperative Forestry and Pest Management. Rept. 88-11. 21p.

- Johnson, D. W.; Hawksworth, F.G. 1988. Reduction of ponderosa pine dwarf mistletoe with the plant growth regulator Ethephon. USDA Forest Service, Rocky Mountain Region, Technical Report R2-42, 10 p.
- Mathiasen, R. L.; Hawksworth, F. G.; Edminster, C. B. 1987. Effects of dwarf mistletoe on spruce in the White Mountains, Arizona. Great Basin Naturalist 46: 685-689.
- Mathiasen, R. L.; Hawksworth, F. G. 1988. Dwarf mistletoes on western white pine and whitebark pine in northern California and southern Oregon. Forest Science 34: 429-440.
- Nicholls, T. H.; Egeland, L.; Hawksworth, F. G.; Johnson, D. W.; Robbins, M. K.. 1987. Control of dwarf mistletoes with a plant growth regulator. In: Troendle, C. A., et al., eds. Management of subalpine forests: Building on 50 years of Research; Proceedings of a Technical Conference; 1987 July 6-9. USDA Forest Service Gen. Tech. Rept. 149: 154-156.
- Nickrent, D. L. 1988. Electrophoretic characterization of host races in hemlock dwarf mistletoe (Arceuthobium tsugense). American Journal of Botany 75(6):2:196. (Abstract).
- Reeves, J. L.; Allen, T. C.; Shaw, C. G., III; Dashek, W. V.; Mayfield, J. E. 1987. Viruslike particles in Armillaria. Proc. 35th Annual Western Forest Disease Work Conference; 1987 August 18-21; Nanaimo, British Columbia, p. 76-83.
- Reaves, J. L.; Allen, T. C.; Shaw, C. G., III; Dashek, W. V.; Mayfield, J. E. 1988. Occurrence of viruslike particles in isolates of Armillaria. Journal of Ultrastructure and Molecular Structure Research 98: 217-221.
- Scharpf, Robert F. 1987. Resistance of Jeffrey pine to dwarf mistletoe. In Parasitic Flowering Plants. Proceedings of the 4th International Symposium of Parasitic Flowering Plants. Ed. H.C. Weber and W. Forstreuter. Philipps Univ., Marburg, Germany. P.745-753.
- Scharpf, Robert F., Richard S. Smith, and Detlev Vogler. 1987. Pruning dwarf mistletoe brooms reduces stress of Jeffrey pines. Cleveland National Forest, California. Research Paper PSW-186. USDA-Forest Service. 7p.
- Shaw, C. G. III; Jackson, R. M.; Thomas, G. W. 1987. Fertilizer levels and fungal strain influence the development of ectomycorrhizae on Sitka spruce seedlings. New Forests 3: 215-223.
- Shaw, C. G., III; Loopstra, E. M. 1988. Identification and pathogenicity of some Alaskan isolates of Armillaria. Phytopathology 78: 981-986.
- Wicker, E.F.; Hawksworth, F. G. 1988 . Relationships of dwarf mistletoes and intermediate stand cultural practices in the Northern Rockies. In: Proceedings-Future forests of the Mountain West: A stand culture symposium. Wyman C. Schmitt, Compiler, Missoula, MT, September 29-October 3, 1986. USDA Forest Service, General Technical Report INT-143:298-302.
- Zimmerman, G. T.; Laven, R. D. 1987. Effects of smoke on dwarf mistletoe seed