

# **PROCEEDINGS OF THE 18<sup>th</sup> ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE**

**Harrison Hot Springs, British Columbia  
September 1970**



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TABLE OF CONTENTS

Page

iii	Forward	
iv	Chairman's Opening Remarks	Robert F. Scharpf
vi	Welcoming Address	Ray E. Foster

PANEL I. HISTORY OF FOREST PATHOLOGY IN THE WEST

1	History of Forest Disease Research in the Pacific Coast States	T. W Childs
8	The Role of W.I.F.D.W.C. in the History of Forest Pathology in the West	R. E. Foster
11	History of Forest Pathology in Mexico	R. Salinas-Quinard

PANEL II. SOLVING DISEASE PROBLEMS IN FOREST LAND MANAGEMENT

19	Role of the Researcher in Solving Disease Problems in Forest Land Management	Donald Knutson
26	Solving Disease Problems in Forest Management and the pest control pathologist	A. C. Molnar
32	The Role of the Educator in Solving Disease Problems in Forest Land	J. R. Parmeter, Jr.
34	The Role of the Land Manager in Solving Disease Problems in Forest Land Management	Royce G. Cox

PANEL III. BIOCIDES IN FORESTRY

39	Biological Degradation of Pesticides	A. J. Cserjesi
44	Douglas-fir Root Extractives - a Search for Naturally Occurring Anti-Poria Compounds and/or Phytoalexins in Douglas-Fir Roots	G. M. Barton
45	Phenolic compounds and <i>Poria weirii</i>	K. C. Lu
49	Christmas Tree Plantation Diseases : Workshop Report	Glenn W. Peterson

SPECIAL PAPERS

51	Predisposition of Conifers by Winter Drying to Disease and Insect Attack	Clinton E. Carlson
54	A Demonstration of Ascogenous Hyphae and Crozier Formation in Hypodermataceous Fungi, and a Discussion of Their Taxonomic Significance	John Staley
60	Quantitative Assay of <i>Macrophomina phaseoli</i> from Soil	Richard S. Smith and Arthur H. McCain
62	Extra Special Report on a New Power Source	R. C. Thobium

APPENDICES:

64	Memorial : Willis Westlake Wagener 1892-1969
66	Active and Terminated Projects
69	Publications
75	Business Meeting Minutes and Financial Report
78	Mistletoe Committee Report
87	Forest Disease Control Committee Report

## FOREWORD

The 18th Western International Forest Disease Work Conference was held September 15-18, 1970, at the Harrison Hotel in beautiful Hot Springs, British Columbia. Ninety-nine members and guests registered.

The conference was called to order Tuesday morning by Chairman Scharpf, a brief welcome was extended, and then the 18th WIFDWC was dedicated to the memory of the late Dr. Willis W. Wagener.

Dr. Ray Foster welcomed the group by extolling the many beautiful and unique aspects of B.C., but warning us to beware of the legendary mountain man, "Sasquich."

The remainder of the morning was spent in reporting new projects, terminated projects, and new or modified techniques. The afternoon session was taken up by the "Old Timers" of WIFDWC who enlightened most of us young fellas on how it used to be in the "good old days."

Wednesday morning saw a series of workshops that were enthusiastically attended, discussed, and reported upon. The dwarf mistletoe and disease control committees also met Wednesday morning after the workshops.

That afternoon, experts from throughout the West lent great insight into the problems of forest diseases in land management.

The meetings activities reached their apex at the social hour and banquet, Wednesday evening. All inhibitions dissolved (or were drowned) and keen competition prevailed among the conferees. Near super human bursts of energy were noted for certain contenders this year, but Jim Kimmey's sustained high level of performance earned him the most coveted award.

Thursday morning saw redeyed, contestants from Wednesday night's ordeal staggering through the rain to the busses for a day in the field. The business meeting was held later that evening.

Friday was kicked off by a very timely and actively discussed panel on Biocides in forestry followed by several invited and special papers. The conference adjourned at noon, the members said "adieu" and vowed to meet again next year in Juneau (or somewhere in the West).

## CHAIRMAN ROBERT F. SCHARPF'S OPENING REMARKS

Ladies and Gentlemen, fellow members, both old and new, guests, it is my privilege and pleasure to call to order the 18th Western International Forest Disease Work Conference. Recognized by pathologists everywhere as the most active, dynamic, and, in some ways, unique forest disease work conference in North America.

I am pleased to see so many of you here today. Before we get started, however, I regret to say that one of our dearest friends and most active and respected members will no longer be able to attend our meetings. As most of you know, Dr. Willis Wagener, consultant with the Pacific Southwest Forest and Range Experiment Station, died just before Christmas last year. Needless to say, Dr. Wagener was a renowned pathologist in his own right. His career spanned more than half a century, beginning in 1917 and ending not just after his 44 years with the U.S. Department of Agriculture but on the day that he died. He was one of the founding fathers of our work conference and served as Chairman for the second conference in Berkeley in 1954. And in the entire history of our organization attended and participated in every conference but one, a record of participation I believed unmatched by any other member.

In my own heart, and I'm certain in the hearts of many of you, Dr. Wagener is not truly gone in that his memory and inspiration lives on. I have little doubt that he is with us in spirit today.

I would like, therefore, to dedicate the 18th WIFDWC to Dr. Willis Westlake Wagener, our dear friend and respected colleague.

At this time I would like to express our thanks to the local arrangements chairman, Jack Hoff and his committee for the fine job they did in arranging for registration, lodging, meeting facilities, transportation, and all the other activities that make this meeting possible.

Appreciation also is due to our program chairman, Al Harvey, who has put together for us and will kick off shortly what appears will be, in usual WIFDWC tradition, a very stimulating and informative program.

I would like to stress, particularly for you newcomers, the air of informality and openness that prevails during this conference, both in and out of the sessions. By all means do not hesitate to ask questions, put forth your ideas and comments, and probably the hardest to do, toss out constructive criticism about any of the topics or presentations. Please do not be afraid, if I may use the expression, "To put yourselves

in harm's way." I know of no one in this conference who has ever suffered in the least from the free and open interchange of information that prevails in these meetings. After all, the real success of this conference depends upon your active participation.

It is my pleasure at this time to introduce a man whom I met and have known since my attendance at WIFDWC. He is currently the Director of the Forest Products Lab here in B.C. and was formerly the Assistant Director of research at the Forest Research Laboratory in Victoria. He was also project leader of the Victoria Forest Disease Project, and is a renowned scientist in his own right. He is one of the "Founding Fathers" of our conference and has the distinction of having been the chairman of the 1st WIFDWC held in Victoria in 1953. His greatest claim to fame, however, is that he has become known as the "Arnold Palmer" of B.C. He has constantly reduced America's best competitor (Toby Childs in particular) to a frustrated, shivering hulk of a man after just 18 holes.

With this background, I would like now to present Dr. Ray Foster who will give us the welcoming address.

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## WELCOMING ADDRESS

Ray E. Foster

Mr. Chairman, Members, and Guests:

It is my pleasure to welcome you to British Columbia on this the occasion of the 18th annual meeting of the Western International Forest Disease Work Conference. This is the fifth time that you have honoured us by meeting in the Canadian far west.

British Columbia is not the largest of Canada's 10 provinces. It rates second in relative area, containing only about 10 percent of the total land area of Canada. Despite this, it has about 25 percent of all of the forest land in Canada and about 50 percent of all of the commercial timber in Canada. Beyond this, it produces about 20 percent of all Canadian pulp, 70 percent of all Canadian lumber, and 95 percent of the total production of softwood plywood. There can be no doubt; you are in the heart of the forest wealth of Canada.

Harrison Lake, and environs, are steeped in the history and mythology of the region.

Approximately 40 miles to the east, on terraces above the Fraser River near the town of Yale, is the famed Milliken dig. This site has yielded evidence of the earliest known existence of man in the western hemisphere. The excavations are believed to have far reaching implications, raising the question as to the antiquity of man in the new world.

Some 40 miles to the west is Fort Langley, established in 1827. This was the first fort north of what was then called Oregon Territory and the first fort south of New Caledonia, as part of northern British Columbia was then called. It was at Fort Langley in 1858 that the colony of British Columbia was first proclaimed by Sir James Douglas, then chief factor the the Hudson's Bay Company and Governor of the still separate colony of Vancouver Island. Douglas was a man of energy and wisdom and no history of the region would be complete without reference to him. No account would be complete, moreover, without reference to our first judge, Matthew Begbie Bailey, the so-called "hanging" judge, who was sworn into office at Fort Langley on the same date. Bailey must surely be a candidate for the most unforgettable character award, and I commend his story to you.

15 miles from here, in 1858, gold was first found in quantity in the Fraser River. River bars such as Hill's Bar and Sailor's Bar were named after those who made their fortunes. Although few succeeded, the madness had struck, and some 30,000 are reported to have left San Francisco to seek their fortunes in the area. Although few succeeded, who can forget the tales of those who did? Doc Keithly, for example, who with three other hungry and desperate men were sitting by a campfire near Quesnel Lake late in November, 1860, debating if they should push on or turn back before the advent of winter. One more creek and one more day it was decided. On that next day the first pan of gravel yielded one quarter of a pound of gold and the great Cariboo gold rush was on. Or who can forget William's Creek. It was there that four men, in one day, gained 37 pounds of gold. Please note the measure of weight in pounds, ounces having proved to be quite inadequate under the circumstances.

In earlier days, Harrison Lake formed part of the Harrison Trail, an alternate route to the north. By 1862 steamboats were in operation on the lake. Even camels were tried, unsuccessfully, over parts of the inland route. The Harrison Trail lost much of its importance with the completion of one of the world's feats of engineering, the Cariboo Road. This road extended some 400 miles from Yale to Barkerville and forced its way through some of the wildest and most awe-inspiring terrain that British Columbia can offer. I am speaking of the world famous Fraser Canyon. Don't miss it!

And finally, it should be pointed out that Harrison Lake is the home of the Sasquatch, those giant, hairy, two-legged beasts which are reported to roam the wilds of this part of the country. The Sasquatch are not to be confused with other hirsute characters seen from time to time on street corners or at the roadside. No, the Sasquatch are more firmly entrenched in our history, being known to and greatly feared by the local Indians throughout their recorded history. There have been sightings of and strange adventures with the Sasquatch over the years, but no generally acceptable explanation of them has yet been found. I strongly recommend that you do not move far from the hotel without suitable external protection or internal fortification.

Members and guests, I welcome you to British Columbia, to Harrison Lake, and to our 18th Annual Meeting.

## PANEL I. HISTORY OF FOREST PATHOLOGY IN THE WEST

James W. Kimmey, Moderator

## HISTORY OF FOREST DISEASE RESEARCH IN THE PACIFIC COAST STATES

T. W. Childs

This glance into the past unfortunately comes too late to be illuminated by Willis Wagener's detailed knowledge of early days, or embellished by Lake Gill's salty comments on failings of our bureaucratic bosses. I am more than a little shocked at finding myself suddenly an old-timer -- fallen into the sere, the yellow leaf -- pinch-hitting for old friends no longer with us.

Even with help from Ernie Wright and Harold Offord I cannot present the factual history that Wag could have given us, so I'll resort only sparingly to facts. Anyone interested in sequences of studies or shifts in programs can find them reflected in the literature and, for recent years, in WIFDWC Proceedings. Effects of power struggles and policy clashes at the federal level, while all too evident on some occasions to workers in the field, are mostly of indeterminate etiology as far as I am concerned.

After a once-over-lightly treatment of our history up to the break-up of the old Division into projects about 8 years ago, I'll favor you with a few pearls of wisdom. Although I must speak primarily of the Northwest, much of our history there was similar to that of California and will no doubt be paralleled in Alaska. I do not hope to equal Lake Gill's talent for strictures and animadversions, but I am not entirely devoid of ability in that line, and will do my best. Any errors in facts in my discourse you can blame on Offord and Wright. My opinions, of course, are not open to question.

Forest pathology in the West Coast States started in 1910, when Dr. E.P. Meinecke was employed by the Bureau of Plant Industry and stationed in San Francisco, under a Memorandum of Agreement with the Forest Service, to study tree diseases. Because of his unique place in our history he deserves discussion at some length.

Emilio Pepe Michael Meinecke was a native Californian, earned a Ph.D. at Heidelberg, where Robert Hartig was his major professor, and subsequently spent several years in

teaching and research at Heidelberg, Munich, and La Plata. His early work in western United States consisted principally of disease surveys, usually from horseback, and heart rot studies, but he did not ignore other problems and was one of the very first to recognize the importance of recreation impact on forests.

I do not know to what extent he used the "diener" system, but he was obviously a competent researcher himself, even though some of his work on rusts was later questioned. What proved to be far more important, he was an expert in selecting promising young assistants and was a superb director and trainer of them. In roughly chronological order, Boyce, Wagener, Lachmund, Gill, and Wright were all trained by him, so in more ways than one he was the father of pathology in the Pacific Coast States.

In later years his pro-German sympathies, maintained even after the monstrosity of Nazism had become apparent, were disturbing to his friends, but I have never heard anyone that knew him really well speak of him except with respect. Some excerpts from a letter by Ernie Wright will show the sentiments of his alumni: "Dr Meinecke was truly a born teacher with unlimited patience...He was a student of the old German school...and he carried forward in the old tradition all the way from official to unofficial duties. He was a hard taskmaster but an inspiring one and I was fortunate to be his student."

When Meinecke was assigned full-time to studies of recreation impact in National Parks throughout the United States, about 1931, work in the California region continued under the direction of Willis Wagener and subsequently under Harold Offord. The program gradually expanded, with greatest emphasis on nursery diseases, root rots, white pine blister rust, and recreation impact. Most of the western work on air pollutants (with the exception of Hedgcock's smelter fume study in northeastern Washington) and much of the work on disease survey techniques has been done in California. Although California has long led the west in air pollution, its leadership is now threatened by 'progress' elsewhere.

Disease research by the University of California developed so gradually that it is hard to say just when it started. Within a few years after initiation of federal research some of the agricultural pathologists had yielded to the fascination of forest pathogens and were publishing occasional papers on the subject. As it became evident that forest protection does not consist entirely of fire control, more attention was given to biological aspects.

For the past several years the university has offered graduate instruction in forest pathology and has also been active in research.

In the Pacific Northwest in 1917, forests were well known to be healthy. There was a lot of conk rot in old-growth Douglas fir but logging would soon remedy that, and other defective species were worthless even if sound. Mistletoe, the only other common disease, was obviously restricted to low-quality stands on poor sites. J.R. Weir, a pathologist assigned to the Northern Rocky Mountain region, has found a few pests in eastern Washington and Oregon, but anyone could plainly see that diseases were a very minor problem.

A half-century later, Childs and Shea (our most authoritative authorities) estimated the total loss from diseases in Oregon and Washington at more than 3 billion board feet per year, less than one-sixth of which is from Douglas fir heart rot. If what you don't know won't hurt you, it was an unhappy day for the Northwest when forest pathology, in the person of J.S. Boyce, was initiated there in 1918.

Boyce's primary assignment was to study heart rots of Douglas fir. Before he was much more than started on this job, several billion feet of timber were windthrown in 1921 in a remote and almost roadless locality where immediate salvage was impossible, and he was called upon to determine how fast the down trees would decay. Also in 1921, white pine blister rust was found in the West, and research on this disease was soon assigned to the Portland office.

Boyce was a phenomenally industrious and capable man, well aware of the existence and probable importance of other diseases, but he could spare little time from major projects. After his departure from the Northwest, in 1928, efforts of the Portland branch for several years were concentrated almost exclusively on blister rust, first in British Columbia and later, following the southward spread of the rust, in Idaho. Consequently, by the mid-1930's we knew a little about diseases in British Columbia and Idaho but practically nothing about them in Washington and Oregon.

Harry Lachmund, who succeeded Boyce, was one of the most brilliant men who ever worked for the old Office of Investigations in Forest Pathology. (This nearly-forgotten

official name is used to avoid invidious comparisons with younger generations.) Most of his research was of exceptionally high quality, but he was not a success as a branch chief.

In 1935, Jess Bedwell was put in charge of a Portland branch afflicted with low morale, poor relationships with the Forest Service, and extensive ignorance of forests in its home region. He rapidly improved working conditions, and gradually shifted emphasis from blister rust to diseases more important in Oregon and Washington. With the transfer of pathology to the Forest Service in 1953, we were relieved of responsibility for the Northern Rocky Mountain region, and morale was helped by a less parsimonious attitude toward pay and promotion. When Jess retired in 1958 I inherited a competent, productive, and harmonious division of the Experiment Station.

Although academic activity in the Northwest lagged somewhat behind California, the University of Washington has for many years had a full-time faculty position in forest pathology, with duties including research as well as teaching. Neither Washington State nor Oregon State University has a full-time professorship in forest pathology, but both schools are active in research and graduate instruction even though professors must squander much of their time on such trivia as food crops. After Ernie Wright retired from the U.S. Forest Service he spent several years on research for the Oregon State Dept. of Forestry, but after his retirement from the state service there was no money available for a replacement until this year.

The place of private industry in our field should not be overlooked. Industry's contribution is relatively small because of the necessity for dividends to stockholders, but the Weyerhaeuser Company's research division has shown that it need not be negligible. Research by industry may be undertaken largely for its public relations value and for the advantage of having specialists to help solve problems peculiar to the company, but it is no doubt attributable in part to the desire of foresters in administrative jobs to contribute to the general welfare.

Federal, state, and private participation in research has most of the advantages and few of the disadvantages of competition. With so much to do, there is plenty of work for everyone. Differences in points of view and different approaches to common problems are healthy. And research organizations hasten the adoption of research results by their parallel management organizations. There is some danger of wasteful competition for funds between federal, state,

and academic agencies, but restraint and good judgment on the part of research administrators can keep this at a minimum.

In Alaska as in California and the Northwest, early work was concerned principally with heart rots. Wright and Englerth made a brief reconnaissance in the early 1940's. Kimmey spent the summers of 1952 to '54 in collecting pathogens of all kinds and in working out cull factors. Baxter published brief observations on a few diseases. In recent years Tom Laurent has been working on heart rots. Since a good pathologist will always find serious problems, we can expect forest diseases to start appearing in Alaskan forest managers' nightmares at any time now.

Probably the most important event in our history was our transfer from the Bureau of Plant Industry to the Forest Service in 1953. As a forester specializing in pathology, I maintain that the advantages of this change have far outweighed the disadvantages. (Pathologists specializing in forestry are free to maintain the contrary.)

The greatest advantage has been in financing. Few if any research organizations can undertake simultaneous investigation of all promising lines, but our difficulties were aggravated by exceptionally acute financial stringencies as well as by the newness and wide extent of our field. We had a lot of irons to heat, and even though we didn't put many in the fire, the fire was too small to get any of them very hot. The snail's pace of research was often discouraging, and morale was further impaired by consistent assignment of lower priority to our work than to pork-barrel projects and costly investigations of the obvious.

(A few years ago a social "scientist" reported, at a cost of many thousand dollars, that people work better if they know that other people consider their work important. Harry Golden, at no cost to the government, had already voiced this conclusion when he wrote, "The sense of being valued enough to be given good tools to work with revives the human spirit and gets the work out." I commend this statement to the attention of financial overlords.)

Improved financing is not entirely a result of the transfer, but I think it is largely so. The Bureau of Plant Industry, an almost purely agricultural bureau, understandably paid little attention to a small unit that was not concerned with apples or artichokes. We enjoyed not being bothered much by Washington, but we didn't enjoy being overlooked when budget increases were possible. A few more reports, and even

occasional interference by someone ignorant of our field, is a small price to pay for the financing that now lets us do a better job. And the asinine directives that sometimes emanate from fools in the Budget Bureau would afflict us, of course, regardless of our organization connections.

Among other advantages of the transfer are closer relationships with National Forest Administration and with other forest researchers. These should be evident to you, and I'll pass over them since I'd like to leave a few minutes for the speakers who follow. I must, however, express my regret that NFA and research offices have become so widely separated physically. Experience has shown that administrative separation is absolutely essential, but I am convinced that both organizations benefit from frequent informal meetings of their people. I know that I often profited from brief conversations with NFA personnel in the hall, or from dropping into their offices for a minute or so, and I trust that the benefits were mutual.

Establishment of well-staffed and well-equipped laboratories, first at Berkeley and later at Corvallis, was a milestone in our progress. Although we cannot solve our problems exclusively in the laboratory, it had been obvious for many years that we could not solve them just by work in the woods. The buildings themselves are far less important than the staffs, whose variety of skills and range of talents make it possible to use the research dollar more effectively. Nevertheless, pathologists are certainly as entitled to decent working quarters as are the pimps of Madison Avenue and Las Vegas.

It is traditional for speakers on subjects like mine to contrast the good old days with the new, and to cry that the glory has departed. (The usual basis for this lament is that youth has departed from the speaker.) There are many things whose loss I regret, but there have been more than enough improvements to compensate for these.

I regret most of all the passing of the wilderness, of places where even God couldn't find you and where there was not a beer can behind every tree. But motel beds are better than blankets on the ground, and modern roads make it possible to get home occasionally during the field season.

When I published garbage it was usually because I didn't know any better. In today's larger organization, where evaluation of personnel by counting publications can hardly be avoided, it is a sad fact that people must publish even if

they have nothing to say. But assistance by technicians, modern data processing, and professional editing make it easier to publish good stuff.

With increased size of the research organization there has been a noticeable tendency at the Washington level to adopt a military attitude in administration. This is unnecessary as well as infuriating, since the military leader's job is to make men do things they are understandably reluctant to do while the research administrator's job is to help them do things they want to do. In compensation, however, the rights and personal welfare of the individual are protected to a considerable extent by definite rules in our 5-foot shelf of Sacred Writings, and are no longer dependent on whether or not he is lucky enough to have a good boss.

In the good old days we didn't have to know much. For example, before Dr Nobles complicated our job, if we knew *Armillaria* and *Echinodontium* we were authorities on root rot and hemlock heart rot. But we didn't have experts on everything from aerobiology to zymurgy to help us. And graduate training was harder to get. You young fellows won't believe me, but it was. There were no Government Training Acts, pay was so low you couldn't save much, and there weren't many jobs for working wives. Fellowships and assistantships were rare, and you had to be mighty lucky to land one even though there were fewer competitors.

So much for the good old days! I enjoyed them, mostly, but the good new days have much to recommend them. For one thing, we can see our results being put into actual use. Even though, or perhaps because, the direct products of our efforts are intangibles, there is special satisfaction in seeing them given material form.

With more researchers and research organizations, intellectual inbreeding is reduced by exposure to diverse points of view. Such mental cross-pollination not only improves the quality of research but also increases the individual's pleasure in his work. I could cite other modern advantages, but this seems an appropriate theme on which to end my discourse. If the young researcher today works hard, shuns bad company, and is properly respectful to his elders, he has the privilege of annual participation in WIFDWC.

THE ROLE OF W.I.F.D.W.C. IN THE HISTORY OF  
FOREST PATHOLOGY IN THE WEST

R. E. Foster

I have been asked to examine the contribution that W.I.F.D.W.C. has made to the history of forest pathology in western North America. To do so, I must examine the history of W.I.F.D.W.C. itself.

This history goes back to November 1952, at which time there was a joint meeting in Montreal of the Canadian Institute of Forestry and the Society of American Foresters. It had been the practice of the late Dr. J. E. Bier, Associate Chief of the then Forest Biology Division of the Canadian Department of Agriculture, to utilize the annual meeting of the C.I.F. as a mechanism to bring together some of his field officers and to review programs in forest pathology of mutual interest. Dr. Lee M. Hutchins, then chief forest pathologist in charge of the U.S. Division of Forest Pathology, U.S. Department of Agriculture, was invited to join one of the evening sessions of the Canadian group. In the discussions that followed it became apparent that while forest diseases had moved back and forth across the border with impunity, forest pathologists had not. It was evident that better communications would have to be developed if we were to encourage the early exchange of information. It was agreed that it would be a good thing to set up a work conference at which our problems of mutual interest could be reviewed in depth.

The formation of the conference was left to the initiative of the western laboratories, and on my return to the west coast I acted to set the necessary wheels in motion. I made initial contact with Dr. Willis Wagener in San Francisco, Dr. Lake S. Gill in Albuquerque, and Dr. J. S. Bedwell in Portland. The consensus of opinion gained was that a work conference would have merit, provided membership was restricted to those actively engaged in the field. It was concluded that groups which would tend to move us towards the larger arena of a general forestry conference should be excluded from membership. It is now difficult to believe but the opinion was expressed that since forest disease situations do not change very rapidly, we might find ourselves with nothing to say if we met annually.

There then followed extensive consideration of where and when to hold our first meeting, who to invite, and what agenda to follow. Time moved on, Victoria was selected as the conference site, a list of potential members was drawn up, and an agenda was well advanced. Then, late in August,

it happened. Dr. Hutchins was advised that he could not gain authorization for more than three members of his Division to attend the conference. This word was received with despair on both sides of the border. Dr. Wagener was the first to act. He outlined three alternatives: (1) find ways to increase U.S. attendance at a meeting in Canada, (2) change the locale of the meeting to the U.S., (3) drop out of the proposed conference altogether.

The first ray of hope arose late in September when Dr. Hutchins advised that additional representatives could attend, at their own expense. Although travel at personal expense was not altogether unknown in those days, it was not expected that the proposal would meet with overwhelming enthusiasm, the distances and costs involved being just too great for those in the peripheral areas.

The U.S. Division of Forest Pathology was not alone in having financial and other problems in 1953. We in Canada also had been told, in effect, to hold the meeting in Canada, or else. Universities were in the same bind; Drs. E. E. Hubert and A. W. Slipp, for example, indicated that they would likely have to attend at their own expense, and proposed postponing the conference to a brighter day.

The days were indeed black, and there was real question if the conference might die before it was fully conceived. The sun in fact did not shine again until early October, at which time Dr. Hutchins was able to advise that he had rescheduled in Portland a meeting originally planned for San Francisco, thus bringing a number of his staff close to the Canadian border, and reducing the financial burden for them to travel to Victoria. The indicated U.S. federal participation suddenly rose from three to thirteen, and the conference was on, rescheduled to mid November.

The birth took place in Victoria at 9:00 a.m. on November 19th, 1953. Thirty-three members were in attendance, or 69 percent of the then recognized potential membership. Five were from universities, 13 from U.S. federal laboratories, and 15 were from Canada. Apart from headquarters representation from Beltsville, Md., and Ottawa, Ontario, our geographical representation at that first meeting included Washington, Oregon, California, Idaho, Montana, Utah, Colorado, New Mexico, Alberta, and British Columbia.

The proceedings of the first conference were printed and my further reference to it will be brief. Suffice it to say that the meeting dealt solely with active programs, the initial objective being to gain a broad overview of who was doing what, and where. To quote from the proceedings,

"It was evident...that parallel and related investigations were in progress and that much was to be gained from the formal review and the informal discussions relating to policies, techniques, and methods...developed to contribute to their solution." Following the formal meeting, one day was spent in the field at Cowichan Lake on Vancouver Island.

This, then, is the relevant background leading up to the first conference. I have gone into this period in some depth because it sets forth our original terms of reference as a work conference. The goal set at that time was to review the circumstances of forest disease problems of mutual concern, i.e., those which spilled over from one region to another. This was, and still is, W.I.F.D.W.C.'s only official role.

I had occasion at our 1962 meeting to look back over our then first decade. I concluded that we had been remarkably successful in keeping our primary objective in sharp focus. I predicted that our second decade would be equally rewarding, provided that we were able to maintain this original sense of purpose and direction. Now, eight years later, I have every reason to continue to be optimistic that we will do so.

Looking back over the past 18 years it is apparent to me that W.I.F.D.W.C. has contributed significantly to the history of forest pathology in western North America. It has done so by providing a better understanding of problems and by establishing that certain avenues of exploration towards their solution would not introduce unnecessary duplication. This is of constant concern to he who holds the purse, particularly if the purse contains public money. There can be little doubt that much potentially excellent work has never arisen from the drawing board because of concern that it might duplicate other good work in progress somewhere else, location unknown. I stress that I am referring to unnecessary duplication. W.I.F.D.W.C. has not fallen into the trap of avoiding duplication at any cost; it has recognized that some of our problems are of sufficient importance to warrant attention by several laboratories simultaneously. W.I.F.D.W.C. has established the formal mechanism for communicating the nature of our problems, what we are doing today to alleviate them, what we are planning tomorrow, and what we have found by way of interim results. But W.I.F.D.W.C. has done much more. In moving about within the region from one centre of excellence in forest pathology to another, it has established professional and personal bonds and the climate that has enabled regional and international co-operation to develop, to grow, and to expand. This, in my opinion, is its most significant contribution to the history of forest pathology in the west.

## HISTORY OF FOREST PATHOLOGY IN MEXICO

R. Salinas-Quinard

## INTRODUCTION

The purpose of this paper is to furnish data regarding the History of Forest Pathology in Mexico of concern to Western North America.

Not many new items will be added to those included in the proceedings of the Eleventh WIFDWC, held at Jackson, Wyo. in 1963 (2) in which references were made to those facts determining the development of Forest Pathology in Mexico.

It is hoped that a brief narrative on present circumstances, compared to those of the past, will give some idea of the handicaps faced by Forest Pathology in Mexico and a view of those obstacles yet to be overcome, to attain a comprehensive and strengthened research and survey of forest diseases.

## THE PAST

In proceedings notes (2,4) it has been mentioned that at the beginning of the 20th century, years 1900-1905, forest disease studies in Mexico were promoted by a member of the Commission on Agriculture Parasitology. It was not until 1954 that purposes of forest research reached formal status; that primary projects on pathology had official support in an organized forestry research institution.

Until 1954 a single technician occupied the position of "Specialist in Biological Sciences", a position among the lowest of job and pay classifications. His responsibilities encompassed surveys and the collection of pathological specimens throughout the forests of Mexico, estimated at more than 16,000,000 acres (1). Besides his regular required duties, and making diagnoses requested in Mexico City, he assisted the Forest Service in seeking solutions to major complicated forest problems.

In the Institution's library, among many volumes dealing with Forestry and Economy themes, were just three documents for the use of the lucky "pathologist" which served as his history of science, bible, and gospel. These were: an incomparable series of publications of the Mexican Society of Natural History published in the previous century, Boyce's "Forest Pathology", and Baxter's "Pathology in Forest Practice".

With these tools, good will and many troubles, acquired theory had to substitute for experience in the performance of a number of very ambitious projects such as studies on pathogen's life histories, cytology, mycology, normal and pathological histology, biochemistry of microorganisms and disease relationships, wood preservation, fungicides and antibiotic screenings, etc., apart of many others, "complementary", on microbiological improvement of textile fibres, or of the roots of "zacaton" (Muhlenbergia); or even more, some diagnosis on the microbiology of rhizomes of "Barbasco" (Dioscorea).

Time was allowed for attending scientific events, at home or away, and assisting in a teaching program which, during 1957 and 1958, complemented a scholarly program on Forest Entomology (Parasitology) of the especialization on forests at the National School of Agriculture. That part related to diseases consisted of two annual four month periods.

Two technicians-a botanist and an entomologist-the only personnel on the staff having professional or scholarly relationships, ably assisted with the surveys. Thus, the "pathologist" had to depend on the availability of the botanist or the entomologist.

It is evident that programming such a variety of purposes could not have followed a definite scheduling but was proportioned with sincerity and an ingenuousness, almost sublimity, that only immaturity and inexperience could justify.

During the five years of novitiate, although suffering from insufficient budget, it was, however, possible to have some work facilities consisting of the combined use of the same laboratory room and its equipment, used by the botanist, the entomologist, a young lady anatomist, and the "pathologist". A desk served as both office and laboratory, complemented by an alcohol lamp, a minimum number of culture tubes, flasks and petri dishes for isolation and culture of fungi and bacteria; reinforced by the common equipment of a microscope, steam-flow sterilizer (an old Arnold's), refrigerator, culture stove, and a photographic camera. It was with these that the first laboratory experiments (!! ) and diagnoses (!! ) were tried.

Field trips for disease survey had to be made when and where the co-workers, the botanist and the entomologist, scheduled field work, because there was only one available vehicle and limited field equipment. In this manner the early surveys were made, always along paved highways and good roads. They were conducted north of Mexico City

across the States of Hidalgo, San Luis Potosí, and Tamaulipas. To the south they were made to Morelos; East through Tlaxcala, Puebla, and Veracruz; and to the West in México and Michoacán. The remainder, the North-eastern, North central and Southeastern zones, had to be left for "better survey opportunities"--surprises for some one in the future.

Change of government administration in 1958 brought employment and organizational changes, among them were the occupying of a new building, and the augmenting of budgetary assignments. Also, a Department of Biosilviculture was created, including several Sections, one of them being analogous to "Forest Mycology" (afterwards "Forest Pathology"). Included were a separate office, a general laboratory room, and a room for preparation of specimens and culture media and for sterilization of glassware. Two people were added to the personnel, and adequate laboratory and field equipment were acquired for the exclusive use of the pathologists. Multiple and organized work programs were defined for three types of objectives: forest surveys, diagnosis and control of nursery diseases and the obligatory services of technical assistance to the Undersecretary of Forestry and Wildlife, his dependencies or for public requests.

The loss of propriety at the School of Agriculture, caused the abandonment of the educational program, but to compensate for it, plans for scholarships were strongly supported in order to provide opportunities for students at the University of Mexico and the National Polytechnic Institute. Short-time training programs of 12, 18, and 24 months were provided.

From 1961 to 1968 a few research projects were done to complement the major research. So, for the first time in Mexico the idea of mycorrhizas in the forest aspect was introduced, although not exactly from the point of view of plant disease relationships but as a morphological basic study for identification. This was followed by other surveys and research on mycology and taxonomy of fungi; host distribution of mycorrhizic, root-rotting, and wood-decaying fungi; fungal and bacterial insect pathogens; pathogenic behavior of *Fusaria*; and, parasitic effects of dwarfmistletoes on pine hosts.

An immediate, positive result from these programs was the appointment to the staff of a young lady trainee whose work immediately was under precise objectives, sampling methodology, and definite co-ordination with silviculture research.

Through the period 1961-1964 the staff was augmented by one more untrained worker. Projects were profusely revised, reorganized and reformed so that by 1965 they were supposed to be sufficiently clarified for quinquennial action. Based on regional purposes, these regional criteria were still too wide and sparse. A series of surveys and researches for the neo-volcanic axis were proposed, comprising an extremely broad area from the Volcano Colima, on the boundary between the states of Colima and Jalisco, to the Volcano Orizaba in Veracruz. Justification was based upon the argument that this geographic area represented very important forest and economic characteristics upon which influences of its population were decisive. Such projects had as general objectives survey and research on nursery diseases, host distribution and evaluation of the cone and stem-rusts, and dwarfmistletoes on pines; also, on mycological problems (molding) of various materials in storage. Under the title of "Time Permitting" a few more research programs were included among which were distribution of root rots and wood decays of standing trees, mycobiology of forestry and nursery soils, and insects; in the former cases with special attention on mycorrhizic and pathogenic fungi, and, in the last, on bacterial infections.

One of the first actions following creation of the North American Forestry Commission and the establishment of its Working Parties, one of which was on Insects and Diseases, was the nomination of official Mexican Commissioners (1962). Appointees were two members of the National Forestry Research Institute. Thus, Mexican Forest Pathology won entrance into a very important international organization.

As a result of Working Party action it was possible for a Mexican technician, a woman laboratory assistant, to take a five-months training course at the Victoria Forest Research Laboratory, in Canada. (3)

## THE PRESENT

### Organization

From 1954 to 1959 may be considered the organizational phase of Mexican Forest Pathology as a part of a Departmental Wood Technology Research Program, and the years 1960 to 1970 could be taken as it's earliest start in a particular research projection.

In Foresters' terminology, in Mexico, the meaning of Forest Pathology is not interpreted, in the broad sense, as disease, affected by any cause, but is considered to refer only to diseases caused by fungi, bacteria or viruses. This definition has been intentionally introduced, hoping that this "unimportant" biological branch may become sufficiently understood so as to be elevated, at least, to a departmental unit within the structure of the official Forestry Organization.

Research, by this branch, has been included in the Department of Silviculture and Forest Management, a part of the National Forestry Institute at Coyoacan (Mexico City) which is under the general direction of the Undersecretary of Forestry and Wildlife, within the Ministry of Agriculture. The Institute is exceptionally invested with prerogatives of technical autonomy. Activities fall under the jurisdiction of the Department of Forest Sanitation, which belongs to another General Direction, called "Protection and Forest Restoration", under the same Undersecretary.

Administrative conveniences in the Institute determined the creation of a very new (1969) Section called Forest Protection and Restoration (like the above mentioned General Direction) which absorbed the former sections of Entomology and Pathology, who in this new organization were termed "Entomology Laboratory" and "Pathology Laboratory" Rooms.

#### Operation Facilities

A dynamic and effective financing administration of the Undersecretary of Forestry and Wildlife, through the National Forestry Research Institute, 1963 allocation, made possible, to a certain degree, better budgetary assignments for operational facilities. However, every department or section in the Institute did not benefit greatly from this better allotment including Forest Pathology, except for some minor requests for materials and equipment but nothing for personnel.

The change from a Section rank to a Laboratory Room category did not cause any real advancement since the sponsored technician still has to outline, alone and by himself, the most pertinent projects and programs.

There is supposedly available sufficient means of transportation, enough field equipment, and four Experimental Forests. The laboratory area has been enlarged by an additional room for seedings and isolations and probably the laboratory equipment is increased beyond the real volume of work and the requirements of only two assistants.

Research and survey programming, from organization to planning and execution, with occasional administrative duties, fall heavily upon the shoulders of two "Pathologists". Consequently, there is a regrettable retardation of work and results. Administrative tasks and other official duties consume much time, attention, and efforts which otherwise, should be fully and advantageously employed, exclusively for research and survey work.

With the assistance of the Working Party on Insects and Diseases, research and survey in Forest Pathology in Mexico has caused a decided impulse, and the head technician has accumulated beneficial relationships with scientists all over the world but especially with those of the United States and Canada, among whom the following esteemed visitors may be mentioned: Dr. David Etheridge (standing tree decays), Dr. James M. Trappe (mycorrhizas), Dr. Roger S. Peterson (cone and stem-rusts) and Dr. Frank G. Hawksworth (mistletoes). Many others, not visitors, were appreciated collaborators, such as Dr. Glenn W. Peterson (foliage diseases), Dr. W. J. Bloomberg (seed and nursery diseases), Dr. R. B. Smith (root infections), Dr. J. R. Sutherland (nematodes), Dr. A. K. Parker (mistletoe controls), Mr. H. S. Farris (seed infections), Miss Chu (wood-decay fungi), Dr. Gordon W. Wallis (root and mistletoe infections) and several others whose names, I regret, cannot be recalled.

#### Programs

The Working Party is also providing strong support for a basic, rational and practical orientation of research purposes in Mexico.

The very impractical extensive projects have now been reduced to such simple purposes as seed and nursery diseases, problems in plantations, light general surveys in forests, and attention to official and public requests.

#### SEQUENCE OF FORSEEABLE ACTIONS AND TRENDS

Indications are that a series of promotions will be required to hasten solution of the problems encountered in developing both surveys and research in Forest Pathology, and their desired promptness and adequacy.

It is well known that to be too insistent on some measures can have dangerous results for the continuity of forest disease research in Mexico. However, the realization of personal responsibility sooner or later impels one to undertake a tactful fight. Hence, foreseeable actions may be as follows: (A) first, to call attention to directives in forestry business-particularly those requiring research; (B) next, when convenient, to submit projects for critical examination, judgment, and approval; and (C) also when convenient, to acquire appropriate coordination and integration, in accord and agreement with the general purposes and interests of the Undersecretary of Forestry and Wild Life, and the Private Chamber of Silviculture Industry. The following is an itemization of desirable endeavors:

1. For an augmentation of personnel, in order to reorganize and advance the projects involving regional objectives, sufficiently planned sampling actions, consistent search and research confirmations, permanent observations, and effective cooperations.
2. To look for ways of arousing interest in Forest Research among investigators and professionals at Universities, Superior Schools, and Institutes, in order to agree on cooperative projects, and productive team-programmation with the National Forest Service. Focusing on common objectives undoubtedly will enhance Mexican research in general, and Forest Pathology in particular. Thus any fulfillments would be expected to benefit national interests.
3. To work on distinctly defining forest disease problems of national interest, and on arranging for positive solutions by priority of actions in research, prevention, and control measures.
4. To endeavor to approach the Forestry Authorities to convince them that the Forest Pathology Branch is a section whose inconvenient functioning is problematical to its own development; while on the other hand, the creation of a departmental division in the National Forestry Research Institute to provide assistance in basic forest research could be definitely beneficial to the economic, political, and scientific circumstances surrounding the general research in Mexico. This proposed departmental division should include at least basic research in Ecology, Taxonomy, Hydrology, Soils, Microbiology, Physiology, Entomology, and Pathology.
5. To fight to persuade Forestry Authorities to recognize that the Working Party, and International Work Conferences and Meetings on Insects and Diseases have been, unquestionably, the main and stronger bridges of scientific and technical relationships. And that their

highly effectual results reflect a relavent influence on the development, orientation, and realization of Forest Pathology in Mexico. Also, that their results make it expedient to support, strengthen, and execute those recommendations arising from the Meetings of the Working Party on Forest Insects and Diseases (3).

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## PANEL II. SOLVING DISEASE PROBLEMS IN FOREST LAND MANAGEMENT

Charles D. Leaphart, Moderator

THE ROLE OF THE RESEARCHER IN SOLVING DISEASE PROBLEMS  
IN FOREST LAND MANAGEMENT

Donald Knutson

By including Homo investigans (Noltingk 1959) in this topic the program chairman tacitly implies that researchers do, or can, function in an important capacity. Many would not be so kind.

Discussing the role of the researcher in disease problems in forest land management is just a fine focus on the question, "What's the role of the specialized researcher in anything?" It's clear from the title that the answer is already known, since it's full of symbols of usefulness. For some reason, employers, stockholders, and taxpayers think researchers should be useful. Not only useful as the coffee club chairman or on the lab volleyball team, but in a professional capacity, presumably in the general area of his training. So the researcher's apparent role, then, is to do research; useful research.

We could stop here, but this is only a general appraisal and our assignments weren't so easy, for we must consider that role of the researcher IN solving disease problems IN forest land management, thus raising the complexity of the question to the third power. At the first level, the researcher's role is to do research, and that is easy to understand. Even at the second level of resolution -- the researcher's role in solving disease problems -- is fairly easy to define, since many concepts we use, such as isolation, inoculation, uptake of compounds, breeding for resistance, etc., can be borrowed from agricultural researchers. To apply them, we need only deal additionally with the size, age, and other unique aspects of trees. But by aiming this double-barrelled question at forest land management, we have a difficult assignment because here the researcher is both a member of a profession and an institution, which often have divergent goals. Historically, researchers were first separate from institutions, then isolated within institutions, and nowadays, integrated into institutions. We'll return to this point later.

The idea that science could be useful became well established when the universe of Newton replaced the universe

of Aristotle in the 16th century. Science and technology converged when stars like Newton, Galileo, Torricelli, Kepler, Bacon, Leeuwenhoek, Harvey, Hooke, and many others in this golden age of discovery, showed nature's actions could be predicted: her energies could be harnessed.

Generally speaking, all the sciences are concerned with understanding and/or controlling the physical world, and naturally some sciences and some scientists put more emphasis on understanding and others put more emphasis on controlling (Klaw 1968). Until recently, it was of little concern to anyone which emphasis the researchers chose, because science was mostly a private activity. Gregor Mendel, Thomas Edison, and Cyrus McCormick paid their own way and the driving impulse was simply intellectual curiosity or an interest in controlling natural forces. Most were homegrown technologists and the theoretical people were somewhat contemptuous of their handiwork. The development of the telegraph and electric lights were not considered proper aspects of science by Rowland, an American physicist in 1883. James Clerk Maxwell, the great 19th century Scottish mathematician and physicist was disappointed in the telephone for two reasons; first, it wasn't developed in the British Isles, and more importantly, it employed no new principles of nature. The telephone was only a particular combination of wire, magnets, and diaphragms which were all understood (Cohen 1948).

But for the most part, the controllers outnumbered the pure understanders. The idea of useful research was here to stay. Louis Pasteur understood the dual role of science, saying: "There is science and the application of science, bound together as the fruit to the tree which bears it." The first agricultural research labs, created from the Hatch Act of 1887, had the same belief: "To promote scientific investigation respecting the principles and applications of agricultural science."

What the researcher's role should be became a relevant question when brave agencies hired them to attack problems for which solutions were desired. But in the minds of researchers, the answer was simply-minded: to research. Research is defined (Gove, Ed 1966) as:

1. Careful or diligent search: a close searching (--es after hidden treasure).

- 2a. Studious inquiry or examination; esp: critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct inter-

pretation the revision of accepted conclusions, theories, or laws (gave his time to --).

b. (1) a particular investigation of such a character: a piece of research, (2) a presentation (as an article or book) incorporating the findings of a particular research, (3) capacity for or inclination to research (a scholar of great --).

Into the late 1940's and early 1950's, the idea was to leave scientists alone, reasoning that if the scientist is the unit of scientific research, he must be free to direct his own work. Cohen (1948) even argues against program planning as was done in the World War II scientific effort. It worked then he states, because targets were chosen with a "reasonable degree of certainty." He thinks it's impossible to predict discoveries or to hurry them into a technology by "managing." He warns against "reading science backward." and exemplifies with the penicillin story (and others). Flemming made his discovery that Penicillium notatum causes lysis of staphylococcal cells in 1928. Ten years later the Florey-Chain team characterized the effective compound and made possible the later large-scale production.

Now the temptation of management is to feel that under proper guidance, the ten-year interval could be reduced to 5 years or 1 year. But Cohen argues that the ten years had to elapse because of what he called the "total scientific situation." In this story, Flemming's discovery occurred at a time when scientists were disappointed with the search for chemical means of disease control. Earlier, Ehrlich had predicted a whole new era of chemotherapy in medicine which hadn't materialized. Pasteur observed microbial antagonism, but couldn't put it to work. He observed that air-borne organisms killed Anthrax cells, but Anthrax still killed chickens inoculated with both. Others found Bacillus pyocyaneus retarded growth of other microorganisms, but results were erratic. Extensive research of the first three decades of the 20th century had not produced a single reliable cure.

But then the wind changed. Domagyk (1935) discovered a sulfa drug which acted against Streptococcus germs, marking the first chemotherapeutic agent effective against bacteria. Yet many diseases (typhoid, tularemia, tuberculosis, and Rocky Mountain spotted fever) weren't affected by sulfa drugs. In 1931, Dubos found an enzyme that would dissolve the coating on pneumococcus cells, thus rendering them susceptible to lysis and he went on to develop gramacidin and tyrocidine. Thus, the scientific climate changed and when Florey and Chain (1938) started systematically investigating the properties of antibacterial substances, it was lucky they chose penicillin, but not improbable as it would have been in 1928.

Cohen further shores up his arguments with testimonials from a former president of Bell Telephone Laboratories, who cautions: "One sure way to defeat the scientific spirit is to attempt to direct inquiry from the top...Successful research goes in the direction in which some inquiring mind finds itself impelled."

The styles changed in the 1960's and research became more corporate and more expensive with federal appropriations for research and development equaling 15% of the annual budget (Nelson 1968). To effectively use these funds, new systems of allocation and control have been established. Researchers still pursue knowledge and understanding, but the way to pursuit is mounted, the rewards and the temptations have changed drastically (Klaw 1968).

Teams, with research and management representatives, try to reduce the time lag between discoveries and their applications. Wigner (1950) distinguishes the capacity and depth of the human mind, with depth related intimately to subconscious thinking. He says that team research can help overcome the limited capacity of mind: "If relativity theory could not be conceived by teamwork, the structure of the George Washington Bridge, and probably even that of the Hanford nuclear reactor, could not have been thought out by a single individual." The underlying urgency of team effort is to provide for the increasingly sophisticated needs of society with either lower amounts or lower grades of raw materials.

We've come to expect useful technology from research efforts, even though researchers have a reputation of persistent unmanageability. Peter Drucker, in 1954, says, "The proper management of professional employees is among the most difficult problems facing the business. It cannot be sidestepped by asserting that the professional employee is part of management...(or) a species of skilled worker. The job of management isn't to change the attitude of the professional employee, but to use him effectively as a professional." But by 1963, Drucker has decided scientists weren't so different from other employees and suggests more active management of research programs and operations.

It seems to me that nowadays the trend is even further in this direction, with the onus of proof shifting from management (to effectively use research talent) to research, (to defend, prove or justify research contributions toward attainment of institutional goals). The trend is obvious when industries, for example, have to prove they're not

polluting, rather than society proving they are. But this emphasis on accountability will bring into sharper focus the conflict of allegiance between the researcher's institution and his profession. Kornhauser (1962) says the problems posed by interactions between professions and work establishments are to be viewed from the standpoint of relations between two institutions, not merely between organizations and individuals. He summarized the conflict: "Professions limit organizations...and organizations limit professions. The researcher has an obligation to maintain professional standards in the face of conflicting demands the establishment might make on him. His special competence is not fully at the disposal of his employer."

Professionally, the researcher could argue that the "viable technology," which research has helped produce, has not created a viable society; that the "scientific explosion" has been largely technological, not accompanied by a comparable increase in knowledge. The attitude of some scientists toward management is expressed in a story: On a visit to Diogenes, Alexander the Great asked if he could do anything to help him and Diogenes replied, "Only stand out of my light," (Kaplan 1964). Management and research are, of course, bonded together by complementary needs. As our burgeoning population exerts its demands, naturally managerial reliance on researchers will increase.

Philosophers worry about too much emphasis on practical science. Bunge (1967) in a chapter called, "Truth and Action," distinguishes scientific theories from technological theories:

"Looked at from a practical angle, technological theories are richer than the theories of science in that, far from being limited to accounting for what may or does, did or will happen regardless of what the decision maker does, they are concerned with finding out what ought to be done in order to bring about, prevent, or just change the pace of events or their course in a preassigned way. In a conceptual sense, the theories of technology are definitely poorer than those of pure science: they are invariably less deep, and this because the practical man, to whom they are devoted, is chiefly interested in net effects that occur and are controllable on the human scale: he wants to know how things within their reach can be made to work for him, rather how things of any kind really are."

"Deep and accurate truth, a desideratum of pure scientific research, is uneconomical. What the applied scientist is supposed to handle is theories with a high efficiency, i.e.,

with a high Output/Input ratio: theories yielding much with little. Low cost will compensate for low quality."

"The technologist, and particularly the technician, are primarily interested in efficiency rather than in truth: in getting things done rather than in gaining a deep understanding of them. For the same reason, deep and accurate theories may be impractical: to use them would be like killing bugs with nuclear bombs. It would be as preposterous -- though not nearly as dangerous -- as advocating simplicity and efficiency in pure science."

Bergmann (1967) cites a difference in viewpoint between a famous teacher and his famous student. Mach, the German physicist, thought the role of the researcher was to collect information by experimentation and observations. Theories were convenient means of ordering incoming information. A student, Einstein, stressed the greater importance of ingenuity and invention in research, saying that the observer must invent concepts that bring order out of the chaos of sense data.

And chaos it is. This is due to the massive amount of information being generated and the fragmentation of science to the point where it's almost impossible for any single man to be a bench scientist, an amasser of data, correlator of data, and inventor of new synthesis (Weinberg 1967).

Weinberg (1967) thinks science is groping for new institutions which would, in effect, put scientists into two classes:

1. Collectors and inventors.
2. Sifters and interpreters (in specialized information centers -- already there are over 400 in the U.S.A. in various fields).

Wigner (1950) sees science trying to solve the fragmentation-communication problem by reintegrating at a higher level of abstraction. Weinberg (1967) reminds us, however, that we then lose resolution: "Quantum mechanics implies all the properties of copper sulfate; but it would be difficult indeed to deduce the blue color of copper sulfate from quantum mechanics." "Knowing in principle is not the same as knowing."

What, then, is the job of the researcher within goal-oriented organizations? Specifically, what should be the role of the researcher in solving forest disease problems

in forest management? There can be no single answer. He must be responsive to both his profession and his institution. Also, he has to heed the "still, small voice" from within, for only this can regenerate his creative vitality. He has to work on both pragmatic and theoretical problems. In summary, he needs to be solving problems which overwhelm him now with their urgency, as well as those which won't be obvious for ten years. The most critical demand upon his personal wizardry is to know when his evaluation of a problem or set of questions is better or poorer than someone else's, and to proceed appropriately.

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## SOLVING DISEASE PROBLEMS IN FOREST MANAGEMENT

### Role of the Pest Control Pathologist

A. C. Molnar

### PERSPECTIVE

My assignment on this panel was to discuss the role of the pest control pathologist. I don't know exactly what a pest control pathologist is but I suspect the title is assigned to various professionals working in the general area of applied forest pathology. At any rate, for the benefit of this discussion we must assume that he shares with the researcher, the educator and the forest land manager

the responsibility for solving disease problems in forest land management.

I am going to take the approach of suggesting to you what the role should be, based on my view of the forest manager's problem, the economic atmosphere in which the problem is tackled and on my view of the role of the other indicated participants. This should provide sufficient provocation to incite discussion.

The economic atmosphere of forest management and the forest management view of disease problems are closely related. While you may be able to point to apparent exceptions, forest management is a business enterprise. Its primary goal is to produce the maximum profit on the investment dollar. And a disease problem to forest management is not so much a:

"Sustained physiological and resulting structural disturbance of living tissues and organs, ending sometimes in death". (Ehrlich 1941)

but rather more a:

"Pest destroying fifty cubic feet of Douglas fir per acre, with a stumpage value of 14.98 per unit which can be controlled now, today at a cost of \$4.00 per acre. It becomes a particularly relevant disease problem if the manager can put the forestry crew on it during the off-season when he might have been forced to lay off this especially good crew". (Pulled out of the air 1970).

The forest land manager is interested in a disease problem not because it is caused by a fungus new to science, nor because it is caused by a fungus which has reticulate aeciospores revealed only by the electron microscope, nor because the careful elaboration of its life history has won the author a Ph.D. He cares because the disease is destroying hoped-for values, is throwing his inventory figures into a cocked-hat and because it is increasing the cost of producing timber or attaining other management goals, thereby reducing profits on the operation. So:

- if he is aware of the impact a forest disease has on the operation, and
- if he sees this impact to be significant, and
- if the cost of reducing the impact is appreciably less than the values saved (taking into account all

those clever formulae evaluating the cost of carrying money for long periods).

Then he will take action against the inroads of that pest.

Obviously, the meaning of the term profit will depend on the aims of management, and the type of ownership, but whether for private gain or for public good, controlling forest pests is a cost proposition and unless the cost is less than the benefit (and I use the term "benefit" broadly), the expenditure becomes frivolous. The forest manager is dealing with practical dollars and cents questions and, while he may be well aware of the necessity of specific diagnosis and that a knowledge of spore characteristics may be needed to achieve specific diagnosis, the question he must ask before he acts is, "Will it pay"?

Before detailing my version of the role of the pest control pathologist, let me give you broad definitions of the functions the other professionals involved in our problem, to place my man in perspective. I am sure this will in no way limit or inhibit the other panel members.

#### Researcher

Establishes the scientific principles upon which the arts of disease diagnosis, appraisal and control are based, i.e., the scientific basis upon which the practical procedures for dealing with forest disease problems rests. And through applied research develops economically and silviculturally feasible procedures for controlling or limiting the impact of forest disease or procedures to enable the forest manager to recognize and take disease damage into account.

#### Educator

Drawing on appropriate scientific disciplines as a foundation, trains future researchers in forest pathology and professional practitioners in the arts of forest disease assessment and control. It is recognized that most educators make a substantial contribution to research but that would have to be classified under the previous heading.

#### Forest Manager

Applies the principles and practices of forestry and business management in order to produce maximum returns on investment in forestry. As a manager he obtains the advice

of various specialists to make policy and operational decisions. When he encounters a forest disease eroding the value of his forest inventory he seeks the advice of a specialist in forest pathology. Through this process he also serves to bring to attention specific instances of forest pest problems through which broader knowledge is gained. He provides test areas for research and surveys.

My fellow panelists will elaborate the contributions made to the solution of disease problems by the researcher, the educator and the forest manager. Presumably, that which is left undone is up to my man, the pest control pathologist.

### THE PEST CONTROL PATHOLOGIST

When we are talking about disease problems down on the forest management unit, we are talking about the real world and about problems that have to be dealt with today, one way or another. Here is a short general list which outlines the type of help required by the forest manager:

1. Identification and delineation of his forest disease problems.
2. Assessment of these problems on the management unit, i.e., an accurate inventory of present and potential losses and their relative significance. Among other things he wants to know which ones he can quit worrying about.
3. Realistic advice about what can be done about them today under the conditions existing on particular sections of his management unit.
4. Someone to adapt known salvage or control procedures to specific problems on his management unit, with heed to local economic and forestry considerations; someone to oversee the companies interests in large scale salvage or control operations carried out in cooperation with government and other agencies.
5. Someone to organize, gear up and supervise the operation of specific salvage and control operations on the management unit.
6. Answers to the questions concerning the cause, impact and control of new forest disease problems on his management unit. This also includes unsolved questions pertaining to known disease problems.

The advice and guidance the forest manager needs to deal with these forest disease problems is sought from a variety of sources which more or less serve his needs. My assessment of these are as follows:

1. Published Research

Of more or less direct relevance to his problem. Specific operational procedures in forestry terms may be available occasionally but usually require interpreting and adapting to the conditions on the management unit.

2. Published reports of specific and general pest appraisal surveys

Usually put out by government agencies. Provide some guidance on the significance of particular pests and indications of trends. More detailed assessment locally needed for management decisions.

3. Research Forest Pathologists

Usually of government or university affiliation but occasionally in private employ. The forest manager is most likely to get direct help from this source if his pest problem is of the classic variety providing a good test situation. Researchers are more likely to provide indirect help as specialists to whom his problems may be referred if pertinent to their specialization. Working on previously unsolved problems, they are not the best source of guidance on questions pertaining to application of established principles. Being specialists they are not the best diagnosticians. An exception is the university (educator) variety. The researcher's prime responsibility is to the institution he serves and he can't afford to become too engrossed in the problems of the local management unit except under special circumstances.

4. Extension Forest Pathologist

Generally of government federal, state or university employ. Most often a generalist at least in responsibility but rarely specifically trained for the demands of the job. Not necessarily a good diagnostician. Commonly overloaded with responsibilities for shade and ornamental tree pathology and forced

by the volume of enquiries to handle problems by mail on the basis of submitted request. Rarely possible for him to give detailed attention to a forest manager's problem.

#### 5. Pest Control Pathologist

The title has been given to a wide variety of functions ranging from extension to supervision control operations, often dealing full time with a single pest. Most often in federal, occasionally state and rarely university or private employ.

In reviewing the needs of the forest manager when faced with forest disease problems, I have perhaps tended to ignore the aspect of the question dealing with the unravelling of the secrets of nature through basic research. I do not wish to deprecate the importance of solid research to meet the needs of the forest manager but, since few of our deliberations neglect this aspect, I did want to focus attention on the aspect that I feel is neglected.

I refer back to the short, and admittedly incomplete, list of items I considered to represent needs of the forest manager in dealing with disease problems. The last one of the six items concern research and there are direct arrangements, primarily by government agencies, to deal with them. The first five represent a more direct and immediate concern for the forest manager. These are not adequately met because I believe they represent a no-mans-land of responsibility. Public agencies provide just enough help to encourage the forest manager into the belief he is getting this service free.

I believe that the forest manager requires direct access to the services of a practitioner of forest pathology to help him with his forest pest problems. This practitioner must be a good diagnostician who will see that a specific label is put on the problem if he cannot do it himself. He must have a good grounding in the basic sciences and have thorough understanding of forest practice. He must be capable of interpreting the published results of forest disease research (or information gleaned through direct contact with research people) as to their relevance to the particular forest management unit. Research should not be one of his functions because, if it is, he is sure to neglect the other areas. But he should be in contact with research people and should help to facilitate their studies in keeping with the interests of his employers.

The employer of the pest control pathologist should be the agency that makes direct use of his services as a practitioner of forest pathology. To smaller employers these services could be available through a private consultant.

To provide practitioners to fill this need I believe the universities would have to offer specifically oriented training analogous to that of the veterinary in animal science. Legally recognized professional standing would have to be the aim.

I would go one step further. I would assign responsibility for both insect and disease assessment and control to this one pest control specialist and eliminate a very foggy situation for the forest manager and the practitioner.

I don't believe these comments represent very original concepts. I would especially welcome the comments of Dr. Charlie Driver who, I believe, has been developing this general area.

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#### THE ROLE OF THE EDUCATOR IN SOLVING DISEASE PROBLEMS IN FOREST LAND

J. R. Parmeter, Jr.

In approaching this topic, I'm intimidated at the outset by the presence of several students or former students who might question my assertions or even offer living proof that I don't know what I'm talking about--although I may be able to prove the latter without help.

The term "educator" cuts a wide swath, as does the term "disease problem". We have just heard an historical panel (or at least a panel on history) in which several of our western greats were deemed fortunate to have been trained by Meinecke and others. In fact, it's often said that employers have to train men all over again to get rid of a lot of damn-fool university ideas. This "on-the-job" training is education, and bosses are educators, often very good ones.

I would like to restrict my remarks to formal educators, who dispense degrees and preside over spring pathological puberty rites. I'm confident that any man in the room could train another man to be a forest pathologist, but only a few of us have licenses to practice.

Aside from research, fund raising, and pontification at professional meetings (activities that, while fascinating topics in themselves, fall outside the scope of this discussion), educators can contribute to the solution of disease problems in a variety of ways. Most of these contributions are probably more subtle than direct, although many students and foresters are notoriously immune to subtlety.

At the undergraduate level, it is especially important that forestry students have a clear grasp and appreciation of forest disease problems and their impact on forest management and productivity. A forester can't rationally tackle a problem he's unaware of or doesn't understand. The role of the educator here is twofold: (1) to penetrate the remarkable density of forestry faculties with the novel idea that, since diseases are an integral part of the forest ecosystem, forest pathology should be required of all forestry students (success to date has been minimal), and (2) to provide the student with the necessary knowledge about and appreciation of disease as an important factor in management.

While teaching undergraduates, the educator can also attempt to lure the most promising students into the field of forest pathology (an occasional limit of large trout modestly and tastefully displayed before students can provide an effective lure). This recruiting function is probably one of the most important contributions of the educator, particularly in an age where forest pathology must compete with a lot of "glamor" fields.

At the graduate level, the educator can influence (hopefully) the kinds and character of training programs. At most institutions, the research Ph.D. is the only doctoral degree available. However, the field of forest pathology encompasses many kinds of responsibilities, some of which require little or no research. Ideally, an alternative degree such as the D.S. should be available to those whose interests lie in the practical application of disease principles to forest management or whose responsibilities are largely diagnostic. It is, therefore, the role of the educator to lobby for more flexible degree choices, and failing to obtain them (as most of us have failed), to stretch the Ph.D. framework to its limit to provide the flexibility required in forest pathology. It is here that the educator's influence is probably greatest.

We're all aware of the "invisible club" and the subtle and not-so-subtle ways in which it influences the directions of research. We live in an era of "basic" research, much of which seems directed more to the titillation of scientific fancies than to the direct solution of pressing problems. When a professor rewards a student with a psychological sugar cube for some esoteric piece of work while at the same time administering a pedantic rebuke for any attempt to grapple with practical control problems, his impact may be (and I think has been) large.

Many workers disdain to tackle problems in control because they seem too mundane for the rarified atmosphere of the "invisible club". I'm not knocking "basic" research; I'm only pumping for balance. Balance can take at least two forms: balance within the programs of individuals or balance among the programs of individuals. In either case, the educator should be prepared to provide degree programs that accommodate a wide latitude in approaches to forest disease research, even to the point of recognizing that some students will want to go into fields requiring little or no research. This, I feel, is the main role of the educator: to see all of the "niches" of forest pathology and to provide workers philosophically and professionally prepared to fill these "niches".

#### THE ROLE OF THE LAND MANAGER IN SOLVING DISEASE PROBLEMS IN FOREST LAND MANAGEMENT

Royce G. Cox

1. "What is disease control worth to the land manager?"
  - A. Theoretically, this should be an increase in yield (long-term allowable cut) equal to at least the cost of control plus a reasonable rate of return on the investment (probably not less than 6% in today's money market). To be considered are the immediate increases in allowable cut made possible by the expected realization of future increased yields. Also to be considered are increases in stumpage value in future markets, but this should be based on true value (profit margin) as related to demand for the product rather than just normal inflation because the latter is relative to other costs which also usually inflate. This is, of course, a difficult requirement to fulfill because of:

- a. The relatively long period of years before actual increased yields are realized, and,
- b. rather nebulous information available on the results of disease control, i.e., at present we must rely too much on estimates and speculation.

Consequently, in actual practice, the forest manager is usually faced with selling disease control on the basis of "faith and hope", which is not competitive with shorter term investments yielding higher rates of return--especially during periods of short money supply.

2. "How is the need for control determined?"

- A. By surveys and evaluation of disease problems. Again, we are weak in applicable knowledge. The effect (growth loss) of some diseases is relatively easy to evaluate, e.g., white pine blister rust, and most of the trunk rots. Others, e.g. root rots, are much more difficult. We need better survey techniques to incorporate into collection of inventory data. We also need better information on the long-term effect of stand improvement practices on the spread of root rots, e.g.; pre-commercial and commercial thinning, cull overstory elimination. If this is a serious problem (and evidence indicates it may be), we will need proven methods of control. Another need is for the effect of trunk scars which inevitably occur during commercial thinning, especially in such species as grand fir and hemlock.

3. "What are the revenue sources for disease problems and how are they distributed?"

- A. Private--With respect to private companies, funds are usually provided only in response to a well-documented budget request. There are exceptions, however, e.g., the 3¢ per acre annual assessment paid for twenty or more years by members of the Clearwater-Potlatch Timber Protective Assn. for blister rust control (state and private lands). This might be difficult to reinstate in view of the failure of blister rust control. Another exception is the pest abatement fund established under Idaho law; this provides for 5% of slash disposal receipts from private timber cutting and State sales. The money is deposited in a fund administered by the Idaho Board of Land Commissioners, and accumulates to a ceiling of \$100,000 at a given time.

Money may be made available on approval of the Land Board, for insect and disease control on private and state lands.

State--On state lands, funds are probably appropriated from the general fund in most cases, although in Idaho a new law (1969) provides for 10% of timber sale receipts to be deposited in a special fund to be used for stand improvement on state lands. This includes thinning, cull tree removal, and I presume insect and disease control where such can be justified.

Federal--On federal lands, funds usually must come from special annual Congressional appropriations. (That's why we need the "National Forest Timber Conservation and Management Act", which failed to pass in 1969.)

Cooperative--Under the Clarke-McNary Law, federal funds are made available for pest control on private and state lands on a 1/3 matching basis, subject to the approval of the U. S. Forest Service. This has been used extensively in the past for cooperative blister rust control efforts, and to a lesser extent for insect control. Currently I understand no CM funds are available except for fire hazard abatement. Whether this may be interpreted to include disease and insect control to reduce fire hazard needs to be clarified.

4. "What kinds of support does the land manager provide for education and research?"

A. Private--I think of three, i.e.:

- (1) Revenue from property and income taxes.
- (2) Direct grants to research.
- (3) Sending personnel to seminars, workshops, short courses, auditing classes.

State--Ditto (2) and (3).

Federal--Ditto (2) and (3), plus leave with or without pay to pursue masters and doctorates.

5. What support is provided the land manager by education and research?

- (1) Answers to his problems (hopefully).
- (2) Collaborative research.

In this regard, I would like to see much greater collaborative "team research" among universities, the federal and state research agencies, private research organizations--such as Boyce Thompson Institute for Plant Research, Stanford Research Institute, and Battelle Memorial Institute--with financial support from the land management agencies both public and private. I think there is a wealth of research talent and facilities available which is not being directed toward or effectively utilized on our forest disease problems.

6. "What types of problems are encountered by land managers with regard to the compatibility of disease control measures with environmental responsibility, and how are they solved?"

- A. We can't ignore the "environmental" problem and shouldn't if we could. The manifold, increasing public demands being placed on forest resources for increased timber supply, more recreation and improved environment are creating new conflicts which make mandatory a much greater effort by all forest land managers.

For example, the practice of clearcutting and prescribed burning is coming under severe attack by the preservationists and environmentalists; yet this practice is deemed absolutely essential by many forest managers as a means of cleaning up the old, decadent forest and preparing the site for reforestation by either natural or artificial methods. Nevertheless, based on recent reports, the use of clearcutting and burning is apparently being curtailed, particularly on federal lands where it has been most widely used, in favor of partial cutting. In my opinion, an intensive analysis of the physiological (soil), pathological, and silvicultural effects of clear cut-burning as compared to partial cutting is needed. Perhaps this is already "in the hopper", but if so I haven't heard of it. Perhaps all that is necessary is a review and summary of existing research data, although I suspect additional research will be required. Questions to be answered are:

1. Is the use of broadcast burning essential

to dispose of the residual debris from old-growth stands and to expose mineral soil for planting and/or seeding (either natural or artificial), or is mechanical scarification more practicable? What are the comparative costs?

2. Can slash be economically disposed of by means other than fire, i.e., mechanical chippers or cutters? Is treatment with slash-destroying fungi practicable?

3. How important is the therapeutic effect of fire in reducing the incidence of pathogens in a cut-over old growth area? I've read and heard conflicting opinions on this question. This should be a relatively easy question to answer, simply by making intensive surveys on areas already treated during different periods in the past.

The environmentalists are also voicing much concern over the use of chemical pesticides for the control of insects and disease. Although not much chemical control of forest diseases exists, better controls are surely needed, and if they are developed there could be a problem. The effect on environment of so-called "biological controls" must also be evaluated, since they may employ "natural chemicals".

#### Conclusion:

If these remarks seem somewhat critical, the criticism is intended to be constructive. I realize that forest pathologists have made and are making dedicated efforts to solve forest disease problems. I also realize that solutions are extremely difficult. Nevertheless, I think there is agreement on the point that better answers to our forest disease problems would greatly improve the land managers' ability to not only meet the "ecological" challenge, but also the challenge of providing society's future needs for wood products.

## PANEL III. BIOCIDES IN FORESTRY

Toni Cserjesi, Moderator

## BIOLOGICAL DEGRADATION OF PESTICIDES

A. J. Cserjesi

In addition to economical production in forestry, there is a problem of protecting the forest and forest products from biological deterioration. The protection of forests from insects, disease and decay is attempted by silvicultural methods and by the use of toxic chemicals. Similarly, in the forest products industry manufactured products can be improved by using resistant wood species, or by use of toxic chemicals to protect the non-resistant wood species. In production, however, a relatively short term protection from biological deterioration is necessary, i.e., during and after manufacture of pulp in the paper industry and unseasoned lumber.

The pollution hazard in the use of toxic chemicals is well publicized. By objectionable application, toxic materials can be introduced into our environment and can cause problems. DDT, for example, which was intended for use against harmful insects, can be degraded only slowly by some soil organisms (1, 2), but because of its unrestricted use, relative resistance and physicochemical properties (solubility in fats, insolubility in water), it has accumulated in the predators of these insects and affected their metabolism.

Impurities in synthetic pesticides can become a problem because of their possible toxicity to humans. 2,3,7,8-tetrachlorodibenzo-p-dioxin, an impurity in 2,4,5-T, is roughly 1,000 times more teratogenic than the major ingredient (3). The dioxin is a by-product of manufacturing chlorinated phenols, and also may be produced when materials containing chlorinated phenols are burned.

The forest products industry has used chlorinated phenols (penta- and tetrachlorophenol) for the protection of wood for decades. The water-soluble sodium salts are used in sawmills to protect lumber against sapstain and mould fungi and the water-insoluble phenols are employed as preservatives to prevent decay in wood in service. The amount of pentachlorophenol used as a preservative is now increasing. Because of its previously restricted application, the pollution potential of chlorinated phenols has been discussed only recently (3, 4).

Bleaching of pulp with chlorine is another source of relatively large amounts of chlorinated phenols (5-7). Most of the waste from pulp mills is treated in biological treatment lagoons or bio-basins to reduce both BOD and the toxicity of the effluent to fish before being discharged into the rivers. This treatment method is empirical, and by research might be improved by searching for more efficient micro-organisms for the degradation of different types of (toxic) chemicals.

Little is known about the biological degradation of chlorinated phenols. Lower chlorinated phenols (mono-, di-, trichlorophenols) are degraded more or less readily, but tetra- and pentachlorophenol are quite resistant to biodegradation (8, 9). Degradation of pentachlorophenol was studied by analyzing the growth media before and after the growth of fungi to detect the depletion of this fungicide (10, 11). Depletion was observed only with *Trichoderma* spp.

Light sensitivity of sodium pentachlorophenate in water was observed in Japan, where it is used as a herbicide on rice fields. After application its toxicity to fish decreased relatively rapidly. A study showed that due to sunlight, pentachlorophenol derivatives were converted to several dimer products which had lower toxicity to fish, although some of these products were highly toxic to micro-organisms (12).

Engel et al. (13) isolated 2,3,4,6,-tetrachloroanisole from wood shavings used in poultry coops. This material was found to be the agent responsible for the musty taste in poultry products. They concluded that this compound was present in the wood shavings as the result of biotransformation of tetrachlorophenol. The chlorinated phenol was originally present in relatively high concentration in the wood shavings which were presumably obtained from a mill planing rough lumber that had been given a sapstain and mould preventive treatment.

Biotransformation of pentachlorophenol to pentachloroanisole by *Trichoderma virgatum* in liquid media has been observed in our laboratory. For the detection of degradation products, an experiment was set up similar to our previous tests (11). After different incubation periods, the mycelium was separated from the medium by filtration, the mycelium extracted with acetone and the medium with ether. The combined extract was methylated with diazomethane and injected into a gas chromatograph. By this method less depletion of pentachlorophenol was observed than by the spectrographic method which we had used earlier; therefore methylation by the fungus was suspected.

To examine this possibility other derivative of pentachlorophenol (silylated) were prepared for gas chromatographic analyses. The resulting chromatograms showed peaks corresponding to pentachloroanisole. This compound was subsequently isolated by thin-layer chromatography and identified as pentachloroanisole by comparing its I.R. spectra and melting point with synthesized pentachloroanisole.

Other derivatives of pentachlorophenol have been identified by Japanese workers in the form of a sulfate in shellfish and glucuronide in rabbits.

All of the above mentioned reactions are detoxication processes resulting from conjugation and therefore do not really constitute degradation of the toxic material. Conjugation means the union or coupling of two substances in living organisms and detoxication implies the reduction or abolition of the toxicity of a substance (15). Detoxication by conjugation is a common reaction in nature: Formation of glycosides (mainly glucosides), formation of methyl and acetyl derivatives, coupling with glucuronic acids, amino acids, etc. Polymerization is a similar process to conjugation but the same compound (or same type of compounds) react to form a polymer. Photochemical reaction of pentachlorophenol is this type of reaction, where dimers, the smallest of the polymers, are formed from the degradation products. In our experiments with dihydroquercetin (DHQ) (16), white-rot fungi precipitated a dark brown material from DHQ solution, possible by oxidative polymerization, which was insoluble in all solvents which we tried. Other examples are also found for detoxication by polymerization (17).

Detoxication products derived by conjugation or polymerization reactions cannot be regarded as the final fate of toxic materials. Biological degradation, meaning breaking down the molecular structure and utilization of the chemicals in the metabolic processes of the micro-organisms, is required to avoid accumulation of synthetic toxic materials in the environment.

Natural toxic materials, such as wood extractives, also can cause problems. We can be sure that some organisms degrade them, since they have not been accumulated in the environment in a natural condition. Industry, however, can upset this balance. For manufacturing, material has to be concentrated in large quantities and the unused material released at high concentration. Thus degradation (of extractives, etc.) can be hindered because of the rapid rate of release into an environment which is not the most suitable for biological degradation.

The use of DDT, and other pesticides, has had a beneficial effect by controlling diseases and thereby improving agricultural and forest production. The unforeseen resistance of some of these agents has resulted in accumulation of these chemicals in organisms and in nature causing an increasing concern about their side effects. This danger becomes greater with increasing requirements for goods, and we have to be alert against future offenses of this type.

The hindrance of the enzyme function exerted by the electronic properties of the chlorine in chlorinated compounds is assumed to be the reason for the slow or negligible degradability of these compounds in sewage sludge (18). Studies of degradation of chlorinated phenols, by fungi (or other micro-organisms) may result in more efficient and practical methods of disposing of these compounds, making possible their use, where necessary, to protect manufactured products.

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DOUGLAS-FIR ROOT EXTRACTIVES - A SEARCH FOR NATURALLY  
OCCURRING ANTI-PORIA COMPOUNDS AND/OR  
PHYTOALEXINS IN DOUGLAS-FIR ROOTS

G. M. Barton

Our interest in Douglas-fir root extractives began as a result of a study initiated at the Victoria Laboratory by Dr. Wallis (1). This study revealed the severity of the *poria weirii* attack to second-growth Douglas-fir and the necessity to find corrective measures if possible.

Since a precedent for emphasizing the protective role of phenolic extractives had already been established (2, 3, 4, 5) we began our study by comparing differences in extractives between healthy and diseased (*poria weirii*) Douglas-fir roots (6). This was necessary since, although several papers had been published on the distribution of the more important phenolic extractives such as, dihydroquercetin and leucoanthocyanidins, in the stem (7, 8, 9), no information was available on the root extractives. As a result of this root study certain extractives common to the stem such as quercetin, its 3'-glucoside and aromadendrin were found to be absent in the roots and therefore could be eliminated as anti-*poria* factors from the study. Other differences such as the absence of dihydroquercetin glucoside in root sections of advanced decay and the presence of unknown phenolic and non-phenolic constituents in both healthy and diseased roots were deemed significant and further studies were undertaken.

The first new compound to be isolated and characterized was a *c*-methyl flavanone I, (10) called *poriol* since it was associated with diseased roots only. It occurred in low yield of 0.2%. A second *c*-methyl flavanone II (11) has also been isolated and elucidated which unlike *poriol* is associated with healthy roots and in high yields of 2.6%. Both compounds have been submitted to Dr. Wallis for anti-*poria* activity and neither has shown significant activity. On the other hand isolated fractions from the roots which contained  $\alpha$ -pinene III have shown anti-*poria* activity. In order to have sufficient material for field testing a commercial sample of Kraft turpentine containing 21% ~~pinene~~ has been provided. The results of this test are not yet available.

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## PHENOLIC COMPOUNDS AND PORIA WEIRII

K. C. Lu

Phenolic compounds have repeatedly been implicated in disease resistance of plants (Farkas and Kiraly 1962). Perhaps the best known example of protection against a pathogen by preformed phenolics is the onion-*Colletotrichum circinans* (Berk.) Vogl. complex. J. C. Walker and his students (Walker

and Stahman 1955) discovered that purple varieties of onion, resistant to the pathogen, contained more protocatechuic acid in their scales than did yellow, susceptible varieties. Catechol was present in scales of a resistant variety but absent in scales of susceptible varieties.

Relatively little has been reported on phenolic defense mechanisms in woody plants. Pyrocatechol, identified in aspen bark, inhibits canker-producing Hypoxyton pruinaum (Klotsche) Cooke (Hubbes 1962). Studies of polyphenols and simple phenols in Pinus monticola Dougl. by Hanover and Hoff (1966) produced some evidence for a quantitative relationship between one polyphenol in the foliage and resistance to blister rust. A. A. Loman presented results of his research on pine heartwood phenolics as related to wood-inhibiting fungi at last year's W.I.F.D.W.C. meeting.

Our research on Poria weirii root rot of western conifers has concentrated on developing fundamental knowledge needed to devise biological control methods. The use of the Poria-resistant red alder (Alnus rubra Bong.) in biological control appears specially promising for reducing longevity of the pathogen. One of the several effects of alder in this regard is its contribution of Poria-inhibiting phenolics to the soil.

In this brief discussion of phenolics and Poria weirii, I will consider only natural occurrence of Poria-affecting phenolic compounds in red alder and Douglas-fir. Our research has not progressed to the point of postulating actual mechanisms of resistance, pathways of phenolic formation, or the liberation of phenolics in plant tissue following infection.

We have tested 25 individual phenolic and related compounds, widely occurring in nature, at two concentrations (0.5 and 2.0mM) for their effects on two isolates of P. weirii in vitro (Li et al. 1969). Growth of both isolates was strongly inhibited in media containing coumarin, 4-hydroxycoumarin, or 7-hydroxycoumarin at either concentration. Salicylic, benzoic, ferulic, o-coumaric, and phenylacetic acids, and o-catechol were inhibitory only at the higher concentration. The remaining compounds either inhibited only one isolate at the higher concentration, had no effect, or stimulated growth of the fungus.

Structural formulae of all compounds tested can be grouped by relative effectiveness in suppressing the pathogen. Though this grouping is obviously an oversimplification, it does facilitate detection of possible relationships between structure and effect of compounds. Clearly the double-ring coumarins stand out as the strongest inhibitors. Within the catechols, benzoic acids, and cinnamic acids, some features

are generally associated with increased inhibition: (1) lack of a hydroxyl (-OH) group, or (2) only two positions on the benzene ring occupied and these in the ortho position, or (3) addition of methoxyl ( $H_3CO-$ ) groups. The phenylacetic acids conformed to the first of these generalities, not to the second, and had no methoxyl groups to test the third.

We are now studying the specific compounds in roots of red alder compared with those in roots of Douglas-fir (Li et al 1970). Extracts from both species have produced no free phenolic compounds. Acid and alkaline hydrolysis, however, has yielded several of the compounds tested earlier for effects on *P. weirii* in vitro. Apparently, the phenolics in roots of both species are present in some bound form.

Ferulic and syringic acids, detected only in hydrolysates of red alder root extracts, inhibit growth of *Poria weirii* in vitro and thus may be associated with resistance of red alder. Only Douglas-fir roots contained p-hydroxybenzoic acid, which appears not to affect growth of *P. weirii* in vitro. The *Poria*-inhibiting vanillic acid and the *Poria*-non-affecting p-coumaric acid were present in both species, so in themselves appear not to be related to host resistance. However, the bound forms of the compounds in the hosts and the hydrolytic capabilities of both pathogen and host must be investigated before firm conclusions on resistance mechanisms can be reached. Synergistic and antagonistic relationships of the respective compounds could also drastically affect their role in host-parasite interactions.

Recently we began studies of phenolic compounds in soil under stands of pure red alder, pure Douglas-fir, and alder-Douglas-fir mixtures. We quickly found that phenolics could not be successfully separated from extracts of the soils we were working with by use of published chromatographic techniques. Accordingly, we concentrated effort on ly one soil, that in the pure alder stand, for development of a workable technique. The technique finally adopted revealed these compounds to be present in the red alder soil: p-hydroxybenzoic, plus two unknowns. Preliminary quantitative data on vanillic acid in each of the three soils has also been obtained. The apparent concentration of this compound, which we rate as weakly inhibitory to *Poria weirii* in vitro, was markedly high in the mixed stand soil than in soil of either pure stand. At this early stage of investigation we are not prepared to interpret these results.

Our overall goal is to model a biological system for control of root diseases in forests, incorporating as many

of the myriad interacting phenomena as possible. It seems likely that phenolic compounds will be important components of the system.

A final word: achievement of our goal requires many talents. Although I am listed as the only author of this paper, Drs. C. Y. Li, Earl Nelson, W. B. Bollen, and Jim Trappe are all deeply involved in the research.

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## WORKSHOP REPORTS

## Workshop 1. CHRISTMAS TREE PLANTATION DISEASES

Glenn W. Peterson, Leader

This workshop was attended by 11 members. Represented were Canadian and United States personnel from both Research and Pest Control. Trends in Christmas tree production were first considered. Most important was the trend towards less use of wildings in the U. S. and more use of trees from plantings established specifically for Christmas tree production. In British Columbia, wildings are still the predominant source; however, there is a trend toward more intensive care of the trees (pruning, shearing).

The pruning and shearing could conceivably have impact on disease increase or decrease. However, none of the participants were aware of any increase or decrease in disease due to shearing or pruning.

Accompanying the trend towards establishment of plantations specifically for Christmas trees has been the increased use of exotics, especially Scots pine in the U. S. For example, Scots pines accounted for 27% of Christmas tree production in the U. S. in 1964. Scots pines are being increasingly used in the northwestern U. S. Producers obtain exotic stock, such as Scots pine, from wherever they can get it, which often involves obtaining stock from nurseries far distant from planting sites. Scots pine for Nebraska plantings have been obtained from Maine, for Wisconsin plantings from California. Such long distance movement of planting stock has already caused an increase in disease problems. Scots pines in Wisconsin have been damaged by the Brown Spot Fungus (Scirrhia accicola) which was introduced on infected planting stock. Scots pines in Nebraska obtained from a Maine nursery were infected with sweetfern rust (Cronartium comptoniae). The potential for damage not only to the Christmas tree plantings but to naturally stocked areas was pointed out. It was also pointed out that the level of infection of nursery stock by fungi such as Scirrhia accicola and Dothistroma (Scirrhia) pini often is so low, that the chances of nursery inspectors detecting and restricting movement of infected stock is slight.

It was agreed that foliage diseases cause the most serious problems in Christmas tree plantings in the Northwest. Rhabdocline disease of Douglas fir and Dothistroma blight of pine species were discussed at length. The status of knowledge regarding controlling or preventing these diseases was considered. It was generally agreed that information on the biology of Rhabdocline disease was sufficient for development of control procedures. However, it was agreed that recommendations for chemical control lacked a firm basis because tests had not yielded conclusive results concerning chemicals to be used and the number and timing of their application, and that recommendations for control through removal of the small centers of infection during years when the disease is at a low level, have not been tested sufficiently. It was pointed out that information was available for control of Dothistroma needle blight in the central United States. However, it was agreed that further information on the biology of D. pini disease in the West was needed in order to develop control recommendations. Further, it was generally agreed that some previous control tests conducted in the West were probably inadequate since they did not encompass all of the period in which infection was likely to occur.

## SPECIAL PAPERS

PREDISPOSITION OF CONIFERS BY WINTER DRYING TO  
DISEASE AND INSECT ATTACK

Clinton E. Carlson

## Abstract

During the winter of 1968-1969 winter drying was widespread and severe in many locations in Montana and Idaho. This study was designed to observe the fate of affected trees. After one year ponderosa pine in light-moderate areas had recovered except for those on severe sites, some of the severe trees were infested by bark beetles and infected by Ceratocystis sp. In severely affected areas young Douglas firs were predisposed to attack by Cytospora abietis and older firs to the Douglas fir bark beetle. This paper is an interim report of a study to be terminated in 1971.

## Introduction

The phenomenon of winter drying of conifers in northern latitudes has been observed for many years. The generally accepted theory is that following a period of very cold weather during which the temperature may remain at 0° F. or below, a warm air mass may move in with above-freezing winds causing rapid thawing and transpiration of conifer needles. Because the roots remain frozen the trees are subjected to an extreme moisture stress, resulting in death of needles, buds, twigs, or whole trees, depending on the duration and intensity of the warm winds (Boyce, 1961).

Nearly 40,000 acres of timber were reported dead following the winter of 1908-1909 (Hedgecock, 1912).

The winter of 1968-1969 was unusually cold in the Northern Region. Temperatures as low as -35° F. were recorded for 2-week periods in the Bozeman, Montana area. Several times during the winter chinook winds occurred. During the very early spring of 1969, reports of winter drying were quite numerous, coming to the Forest Insect and Disease Branch from all segments of the Region. Preliminary observations of several of the affected areas indicated varying degrees of injury, including death of nearly all needles and buds on trees affected east of the Continental Divide to minor needle burn on some areas west of the Divide.

A search of the literature indicated very little has been done concerning the resultant effects of winter drying. Therefore, we designed a study to answer the very basic question, "What is the fate of trees affected by winter drying?"

Specifically, the objective of this study was to observe affected trees for a period of years to find out if they would recover, die or be invaded by insect and disease. This paper is an interim report based on data collected to 1970. The study will be terminated in 1971.

### Methods

Three areas were arbitrarily selected for study on the basis of general severity of injury. Area I in the Swan Valley of western Montana was rated light. The main species affected was ponderosa pine (Pinus ponderosa) in a belt of the west side of the Swan Range at 4,500 feet M.S.L. (Mean Sea Level).

Only foliage was affected. Very few buds appeared to be dead and no terminal branches were killed. Needles were necrotic from the tip for about 1/2 their length. The entire affected area appeared greenish-brown in perspective.

Area II in the Flathead Valley of western Montana was rated moderate. The main species affected again was ponderosa pine in a belt at 4500 feet M.S.L. on the west slope of the Mission Mountains.

Approximately 20-30 percent of the buds appeared to be dead on trees in this area, and 80-100 percent of the length of foliage was necrotic. The area appeared distinctly tannish-brown.

Area II located in the Bozeman Valley in eastern Montana was severely injured. Lodgepole pine (Pinus contorta v. latifolia), limber pine (P. flexilis), and Douglas fir (Pseudotsugae mensezii) were equally affected.

Seventy-five-80 percent of the terminal buds on affected trees were dead. All foliage was completely dead and many leaders appeared lifeless. This area was distinctly bright reddish-brown in perspective.

Within areas I and III 3 plots were established and in area II 4 established to provide a basis for subjective analysis of affected trees. Each plot consisted of 15 trees

of varying height, diameter, and age selected arbitrarily along irregular transects. At the time of study establishment in the spring of 1969, and subsequent evaluations in the fall of 1969 and the spring of 1970, trees were observed for:

1. Estimated necrotic length of foliage affected.
2. Proportion buds dead.
3. Proportion leaders dead (terminal and laterals).
4. Associated diseases or insects.
5. General appearance.

### Results and Discussion

All data collected was subjective in nature and was not analyzed by classical statistical methods.

Area I: Only ponderosa pine was studied as Douglas fir was not affected. At the initial reading needles were necrotic for 1/2 their length. No buds or leaders were dead, but trees appeared unhealthy. The 1970 evaluation showed no dead buds or leaders, affected needles had fallen and all trees had regained a healthy greenish appearance with no evidence of insect or disease activity.

Area II: Again only ponderosa pine was studied as Douglas fir was not affected. At the initial reading, 80-100 percent of the foliage length was necrotic and 20-30 percent of buds observed were dead. No dead leaders were noticed and no insects or diseases were found. The 1970 evaluation revealed most trees had recovered as in Area I. However, in one plot on a relatively dry site Mountain pine beetle (Dendroctonus ponderosae) and red turpentine beetle (D. valens) were observed in 3 trees, two of which had died. Blue stain fungus (Ceratocystis sp.) was associated with the beetles.

Area III: Douglas fir, lodgepole pine, and limber pine were the species studied. At the initial reading, 75-80 percent of terminal buds and all foliage were dead, and 20-30 percent of the terminals were dead.

No insects or diseases were found. The 1970 evaluation showed all affected foliage had fallen and new foliage was very sparse, giving the trees a very unhealthy appearance. Douglas fir beetle (D. pseudotsugae) was evident in five trees of one plot. In the other two plots all of the Douglas fir were infected with Cytospora abietis causing girdling stem cankers. No other pathogenic fungi were found.

The evaluation indicated damage caused by winter drying west of the Continental Divide was restricted to

necrosis of needles except in a few localized areas in which affected trees were on severe sites. On these sites bark beetles may contribute to death of some of the trees.

In Areas I and II, ponderosa pine was the only species affected. Douglas fir was present in numbers equal to the pine but apparently was much more resistant to winter drying.

East of the Continental Divide the situation was different. Douglas fir and lodgepole were most severely affected. Many buds and terminal branches were killed outright. In the larger firs, bark beetles were found and in many of the smaller the fungus Cytospora abietis was established. While Cytospora will only hinder or prevent recovery of affected trees, the bark beetles could build up and represent a threat to healthy firs unaffected by winter drying. No insects or diseases were found in lodgepole even though the species was severely affected by winter drying. All plots will be given a final evaluation in spring of 1971.

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#### A DEMONSTRATION OF ASCOGENOUS HYPHAE AND CROZIER FORMATION IN HYPODERMATACOUS FUNGI, AND A DISCUSSION OF THEIR TAXONOMIC SIGNIFICANCE

John Staley

Are species in the coniferous Hypodermataceae correctly delimited by Dr. Grant Darker's (1931, 1967) taxonomic treatments? Will use of his concepts allow us to correctly appraise life cycles and identify sources of inoculum? Species concepts in these fungi are clearly important to forest pathologists and are fundamental to most of the other information we collect to guide our activities.

Darker's species concepts have stood the test of my observations and experiments both in the laboratory and the field. His species correlate well with discreet patterns of disease development in forest stands. I would however add to his species several that he did not describe, or sort out some few organisms mistakenly included with others.

Studies of ascocarp development and nuclear phenomena by Dr. Clancy Gordon (1966, 1968) have been presented to suggest basic and novel concepts have been gained that:

- a. allow division into centrum types within the Hypodermataceae on a meaningful natural basis, perhaps parallel, in a small way, to Luttrell's (1951, 1955) larger work, and
- b. give insight to unique species concepts.

Hart Bynum's new needle cast in Oregon offered a chance to study Gordon's developmental and nuclear criteria without directly duplicating his efforts. The results of this study are most interesting. The techniques developed have so far been applied to examine ascus development and nuclei of 12 fungi including Lophodermium, juniperinum, Elytroderma deformans and other representatives of Gordon's "Type I," "Type II," and "intermediate" centrum types.

The preparations most used in this study were: squash mounts stained with either phloxine-KOH-india ink or hemitoxylon, and whole mounts stained in cotton blue-lactic acid of hemitoxylon; frozen and paraffin embedded sections stained with orsiellin BB or cotton blue were used for reference, as were several other nuclear stains, Giemsa, Lacours aceto-orcien, and trypan blue. Phase contrast and darkfield illumination were sometimes used. With few exceptions the photographs I will show are of phloxine or hemitoxylon stained preparations<sup>1/</sup>.

First I will present my findings in a nutshell, using several species for illustration. Second I will discuss the claims of several authors. Third I will discuss various interesting aspects of my study, and will conclude with a developmental series on E. deformans.

Briefly I found that, as shown here for Lophodermella sp., Lophodermium juniperinum, Lophodermella arcuata, and Lophodermium decorum, the asci develop from an ascogenous hyphal system, and that crozier formation is commonly evident though apparently not required. The different species show some variation in frequency of crozier formation and visible extent of an ascogenous hyphal system. Although nuclear staining procedures are somewhat rigorous, the nuclei can be followed through this developmental process as shown for Lophodermella arcuata and be seen to fuse in the young ascus.

<sup>1/</sup> I would like to express my thanks to Dr. Francis Uecker for advice concerning some of these techniques.

It is inaccurate to describe these fungi as uninucleate or binucleate. Cells in the developing ascocarp are uni to pluri nucleate with a strong tendency in different tissues toward the uninucleate or binucleate condition. My evidence is as yet insufficient to conclude that paired nuclei divide simultaneously but this may well be so within the ascogenous hyphae.

To return to conclusions of previous studies, Killian and Likhite<sup>7</sup> (1924) illustrated their findings on Lophodermium hysteroides as shown. They claimed crozier formation. They also show multinucleate cells. This is hardly a confidence inspiring illustration, but the authors (1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, and 1925), alone or in collaboration had for the previous 7 years some 8 publications on developmental studies of various ascomycetes. Illustrations in their earlier papers were apparently more carefully drawn.

Jones (1935) study seems to have been the best such study of any needle cast fungus. Remember he had published similarly on Ophiobolus graminis and Rhytisma acerinum 9 to 11 years earlier (Jones, 1923, 1925, 1926). It is safe to assume he had both the techniques and the experience well in hand. His study revealed croziers, ascogenous hyphae, ascogonia and trichogynes.

Gordon's (1966) results are quite different. He divided a number of needle cast fungi into two "centrum types" plus an "intermediate" type. "Type I" develops from uninucleate hyphae. "Type II" from binucleate hyphae. Asci arise from anastomosis of vasa cells in "Type II" the two nuclei are said to be present initially and anastomosis of paraphyses was not observed. Asci are said to grow out as shown here and pictured here.

My results agree largely with Jones. They disagree with Gorgon's conclusions on each of the points mentioned above. I have been able to trace the ascogenous hyphae back to enlarged plurinucleate cells such as this one shown in a whole mount stained with hemitoxylon. Evagination of the basal cells of the paraphyses has been observed but no photographs could be obtained of a developmental sequence leading to ascus formation. Gordon's illustration is inadequate to be offered as proof of such a process and his publication is lacking presentation of such a developmental sequence. In contrast, evagination of cells of the paraphyses can in early stages of development be clearly shown to result in branched paraphyses.

Ascogenous hyphae can be detected running at right angles among the bases of the paraphyses. There are interesting structures of undetermined function present and occasional croziers at intervals along such hyphae. These again are the enlarged cells from which the ascogenous hyphae originate. As the ascogenous hyphae mature, the older cells of the system lose their cytoplasm. This movement of cytoplasm into the growing points of the system is characterized throughout its development. The ascogenous hyphae are more distinct in organisms subject to intermittent adverse weather conditions than they are in the new Oregon needle cast. This may reflect a higher priority for nutrients under rigorous conditions in ascogenous hyphae as compared to somatic tissue. Phase contrast reveals the ascogenous hyphae as illustrated. Under darkfield lighting, their cytoplasm is seen to be less granular and they are almost invisible. Ascogenous hyphae frequently stain more darkly than the surrounding tissues in lightfield KOH-phloxine-ink mounts. They are of course most clearly seen when they are not hidden by paraphyses.

I will now show a developmental series for E. deformans.

In the early stages of ascocarp development there is a parallel layer of hyphae shown here in a whole mount. If stained and carefully lifted out, this layer is seen to be largely uni and binucleate. In slightly more mature ascocarps one can find beneath this layer of parallel hyphae, larger hyphae with nuclei that are frequently larger and less dense. These larger hyphae I interpret as ascogenous hyphae. They can be traced back to enlarged multinucleate cells in which the nuclei are sometimes paired. One could interpret these as ascogonia. I have not found how they arise. The ascogenous hyphae become more abundant as the ascocarp matures. Sometimes croziers can be seen but E. deformans appears to more commonly develop asci without crozier formation. In E. deformans as the ascogenous hyphae mature the nuclei stain more faintly than nuclei of somatic hyphae and do not photograph well, but direct microscopic examination indicates the nuclear sequence in ascus development is similar to that in L. arcuata. In the young ascus one can see paired nuclei that fuse as the ascus enlarges. The fusion nucleus divides in a series of steps, partially illustrated here, that lead to spore formation. During spore formation the nuclei begin again to stain with more contrast.

Anastomosis of the paraphyses has been observed in E. deformans but is not apparently involved in ascus development.

The title promised a discussion of the taxonomic significance of all this. I believe that the differences in ascocarp development are insufficient to serve as criteria for any profound subdivision in this group of fungi. My results challenge Gordon's alleged differences in: nuclear condition, hyphal anastomosis, and ascus development used to separate "Types I" and "II". "Type III" (Gordon 1968) is subject to some of these criticisms, and to others, but I am not going to enlarge further on "Type III" today.

If the significant function of the hyphal anastomosis in the base of the centrum is not nuclear exchange, what is it? Paraphysate cells in this area do lose their cytoplasmic contents and apparently this allows space for the asci to push through. Perhaps the anastomosis provides structural support for tissues surrounding the enlarging asci.

The results of my study may be used to challenge conclusions that could form either part or all of the basis for reorganizations at variance with traditional taxonomy in the Hypodermataceae. The fact of the matter is: no recent proposals at variance with Darker's concepts of taxonomy in the Hypodermatacea have been coherently presented. I prefer not to appear to be erecting a straw man. So I must limit myself to three concluding points:

- a. Events leading to development of asci in the Hypodermatacea follow a traditional sequence long known in many ascomycetes.
- b. Gordon's centrum types "I" and "II": (a) suffer from inaccurate description and (b) lack adequate supporting evidence of developmental sequences claimed.
- c. Future taxonomic changes must recognize, in large, the validity of the developmental sequence described by Jones (1935) and similar evidence on other species presented here today.

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## QUANTITATIVE ASSAY OF

### Macrophomina phaseoli from Soil

Richard S. Smith and Arthur H. McCain

The charcoal root disease caused by Macrophomina phaseoli has been the most important root disease problem in the forest nurseries of California. The pathogen overwinters and survives unfavorable conditions as sclerotia in the soil or in infected roots. Host plants are infected when the growing root come in contact with sclerotia in the soil. The fungus has a wide host range of many native weeds and cultivated plants, including most of the usual nursery cover crops. There is the distinct possibility that M. phaseoli populations are building up in the nursery soils on the roots of these cover crops and/or on the roots of native weeds during fallow periods. Up to now it has not been possible to determine the extent of the population increases because there was no method of assaying the soil for microsclerotia. This past year, by combining two assay methods (1) wet sieving and (2) a selective medium, a technique has been developed for the quantitative isolation of M. phaseoli from soil.

A five-gram sample of soil is placed in a blender with 250 ml of 0.525% sodium hypochlorite. The sample is stirred at the slow speed for 30 seconds and every 5 minutes for a total treatment time of 15 minutes. The sample is washed through 0.088 mm and 0.044 mm sieves and the material on the 0.004 mm sieve is collected by backwashing.

The sample from the sieve is washed into a 100 ml bottle and 100 ml of PDA media at 55°C containing 0.5 ml of 5.0% streptomycin sulfate and 0.125 ml of 5.25% sodium hypochlorite is added. The bottles are shaken and the suspension is distributed into petri dishes. Incubation temperature is 31°C. The plates are examined in 3 or 4 days. The colonies of M. phaseoli are readily identified by the numerous black sclerotia that develop. Occasionally Aspergillus niger and Neurospora

sp. colonies occur on the plates.

The distribution of the sclerotia sizes from a 20-gram moist soil sample (17.6 g air dry) from a series of sieves is as follows: 0.037 mm - 8; 0.044 mm - 21; 0.053 mm - 33; 0.062 mm - 50; 0.088 mm - 7; 0.104 mm - 3; 0.177 mm - 0; 0.250 mm - 1. This indicates that 84% of the sclerotia are obtained when only two sieves are used; 0.088 and 0.044 mm.

EXTRA SPECIAL REPORT  
ON A NEW POWER SOURCE

R. C. Thobium

In these days with ever-increasing demands for power, it may come as a surprise to learn that a completely untapped power source exists throughout the West. Why not harness the explosive power of the fruits of the ubiquitous dwarf mistletoes (Arceuthobium spp.) of western conifers? These parasites have long been known (2), but their potential importance as a power source has not been recognized. Each dwarf mistletoe fruit contains a single projectile-like seed (about 1/10 of an inch long) which at maturity is ejected at speeds of about 90 feet per second (4).

The following discussion shows the potential energy now being lost through wasteful seed dispersal in just one part of the West. For this paper I have chosen the power-poor Southwest (Arizona and New Mexico) for an example. Here it has been determined that ponderosa pine dwarf mistletoe occurs on  $2.5 \times 10^6$  acres (1). Estimated seed production by this same mistletoe (3) averages about  $25 \times 10^4$  seeds per acre. Thus approximately  $6 \times 10^{11}$  mistletoe seeds are produced annually just in the ponderosa pine type. Estimates of the force of the seeds based on their weight ( $2.7 \times 10^{-3}$  grams) and velocity (2540 cm/sec.) indicate that each develops  $8 \times 10^{-8}$  horsepower. When we multiply this times the number of seeds produced we have  $48 \times 10^3$  horsepower or (among friends) 50,000. Converted to more conventional terms this represents 67,000 kilowatts!

It should be kept in mind that this is the potential of only one part of the West. Vast additional sources exist in mistletoe-infected pine, fir, larch, and hemlock forests throughout the West.

It might be only fair to mention some slight difficulties in the potential development of this resource, but none of them need to be considered insurmountable. The harnessing of the power of billions of tiny fruits scattered over millions of acres presents somewhat of a problem because the energy from an individual fruit may have to be harnessed during about  $2 \times 10^{-4}$  seconds when seed ejection occurs. Another minor handicap is that this power source would be available only during the seed dispersal period which lasts about 2 to 3 weeks. But with application of typical American ingenuity and know-how, a multi-billion dollar crash program

for development of this resource into a year-around power source could be expected to produce spectacular results.

The harnessing of this power source would have many national advantages--1. it would enable us to beat the Russians at another game because their mistletoe power sources are puny in the extreme compared with ours; 2, but directing the seed power to more useful purposes rather than (as nature intended) toward debilitating our forests, our trees' sense of well-being should be enhanced; and 3, it would negate the need for additional Colorado River dams and thus help "Save Grand Canyon".

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## APPENDIX I. --- NECROLOGY

WILLIS WESTLAKE WAGENER  
1892-1969

Willis Westlake Wagener, a longtime member of the Society and a lifelong research pathologist with the U.S. Department of Agriculture, died December 9, 1969, at the age of 77. His death brought to a close a long and distinguished career in pathology. His career spanned more than half a century, beginning in 1917. He served for 44 years in the U.S. Department of Agriculture, starting as a forest pathologist under the late Dr. E. P. Meinecke during the formative period of both forestry and forest pathology. Even after retirement as principal pathologist in 1962, he continued as a consultant at the Pacific Southwest Forest and Range Experiment Station where, at the time of his death, he was at work on completion of several manuscripts. His had been a career singularly devoted to research and notably successful in all respects.

Fifty-two years of productive research on forest disease problems in California and the Western United States presents a record that is probably unique. Dr. Wagener's name, like Dr. Meinecke's, will always be associated with the grand period of pioneering research and with the studies that have established the solid foundation of fact on forest diseases in California and other parts of the West. Throughout his career he combined the eye of the practical and knowledgeable forester and botanist with that of the well-trained pathologist to give technical depth and practical substance to his findings. A list of his many publications is, in effect, a list of the major disease pests in California forests.

Dr. Wagener was born in Salida, California, September 10, 1892, and attended local schools. He received his A.B. in botany at Stanford University in 1918, took his Master's Degree in plant pathology at the University of California, Berkeley, in 1928, and his Ph.D. in forest pathology at Yale University in 1934. He is survived by his wife Ura Maude Wagener, a son H. Heath Wagener, and a daughter Susan W. Hellyer. He was a member of the American Phytopathological Society, Society of American Foresters, Mycological Society of America, American Forestry Association, California Alumni Foresters, California Academy of Science, National Shade Tree Conference, Stanford Half-Century Club, FSX Club, Fifty-plus Club of Stanislaus County, Cofounder and Honorary Member of the Western International Forest Disease Work Conference, and a concerned supporter of The Nature Conservancy.

Dr. Wagener had broad interests in both forestry and forest pathology. His special interests included the study of plant rusts and the relation between forest diseases and climate. In school he had become interested in cypresses, partly because there are so many species native to California, and he became recognized as a world authority on the diseases of cypress. A conifer root disease fungus, Verticicladiella wagnerii Kendrick was named after him by a fellow pathologist and admirer. He was also devoted to the cause of conservation, and had successfully operated his personal reforestation project at a tree farm which he started in a burned-over area near Plumas National Forest, California. He was a past chairman of the Western Chapter of National Shade Tree Conference, and prepared shade tree lists for the organization. He worked on ventilation requirements in structures and provided ventilation requirements for FHA.

National and international recognition has been accorded Dr. Wagener for his monograph on diseases of cypresses and for his publications on Coryneum canker, white pine blister rust, native western rusts, heart rots, and root and foliage diseases. Forest managers have accepted and used many of his findings on the impact of fire, weather, and noninfectious disorders on the vigor and stability of forest stands. He pioneered research on the relationship of tree defect to tree hazard in recreational forested sites, and played a leading role in establishing tree hazard guidelines for practicing recreation land managers--Federal, State, and private. In this latter role, his expert testimony served judicial objectives in several well-known tort claims in court.

Association with Willis Wagener was to work with a man of great kindness and old-fashioned gentility, and a person possessed of a generosity of spirit, one in whom there was no malice. His loss is mourned by those who knew him as a friend as well as by fellow scientists. He leaves to all his associates a legacy of scientific contributions and enduring memories of his friendship and help. (Robert V. Bega)

## Appendix II -- Active Projects

## New or Modified \*

C. Cone, Seed, and Seedling Diseases70-C-1 Nursery Disease.

Objective: (1) To determine the most effective chemical treatments for disease control, particularly conifer seedling damping-off. (2) To determine the nature of phytotoxicity caused by certain fungicides and to determine whether "safe" fungicides are detrimental to the physiology of tree seedlings (3) To investigate new nursery tree disease problems and to determine their relative importance to nursery tree production (H. Zalasky)

70-C-2 Effects of pest control practices on Douglas-fir seedlings.

Objective: (1) To determine whether pest control practices affect mycorrhizae of Douglas-fir seedling and (2) To determine any interactions as they affect growth, size, and variations of the seedlings. (W. A. Sinclair-Cornell University, Work being done at Weyerhaeuser Forestry Research Center)

H. Stem Diseases - Rust and Cankers70-H-1 Canker Diseases of Poplar.

Objective: (1) To determine major disease problems in the western interior of Canada. (2) Determine the incidence of cankers caused by Septoria musiva Pk. and S. populicola Pk. in balsam poplar seedlings and the susceptibility of plains cottonwood seedlings to S. musiva. (3) Determine the susceptibility of hybrid poplars to S. musiva and Diplodia tumefaciens under field conditions. (4) Determine the species of Mycosphaerella on Salicaceae, their distribution, life history and taxonomy. (5) Clarify the taxonomy of Diplodia tumefaciens. (6) Determine pathogenicity of Rhytidiella moriformis Zalasky (H. Zalasky)

70-H-2 Nutritional and environmental requirements of axenically cultured Ribes tissues.

Objective: To modify substrates developed under 66-H-2 which have shown promise in culturing cambial tissues of Ribes spp. to effectively grow other tissues of this genus

\* For a complete listing see Fifteenth and Sixteenth Western International Work Conferences, 1967 and 1968.

for the in vitro study of the binucleate phase of Cronartium ribicola. (A. E. Harvey.)

70-H-3 Pure culture of Cronartium ribicola from its vegetative stages.

Objective: To establish and propagate the vegetative stages of Cronartium ribicola in pure culture. (A. E. Harvey.)

70-H-4 Nutritional and environmental requirements of white pine tissue cultures infected with Cronartium ribicola.

Objective: To study the effect of pathogenesis by Cronartium ribicola on the normal nutritional and environmental requirements of cultured white pine tissue and to examine the effect of artificial changes of the host environment on the growth and morphology of the parasite. (A. E. Harvey.)

70-H-5 Isolation and identification of the specific factors supplied by host tissues that are required for the independent survival and growth of Cronartium ribicola.

Objective: To determine the factors responsible for the survival and growth of Cronartium ribicola on complex organic substrates. (A. E. Harvey.)

70-H-6 The influence of blister rust (Cronartium ribicola) on the seasonal distribution of carbohydrates in needle and bark tissue of western white pine.

Objective: To determine the effects, both qualitative and quantitative, of blister rust on the seasonal distribution of carbohydrates within needle and bark tissue of Pinus monticola. (B. L. Welch and N. E. Martin.)

70-H-7 Amino acid utilization profiles for different isolates of Tuberculina maxima.

Objective: To develop amino acid utilization profiles for several isolates of T. maxima to determine if they are physiologically different in this respect. (E. F. Wicker).

## Appendix III --- Terminated Projects

- 58-A-2. Studies of native and introduced Populus spp. (W. J. Bloomberg.)
- 53-D-4. Characteristics and ecology of the root system of western white pine. (R. G. McMinn.)
- 64-F-1. Cytology and ontogeny of Arceuthobium douglasii, A. americanum and A. campylopodum F. laricis. (C. C. Gordon.)
- 57-G-10 Ecology of branch stub infection in aspen. (D. E. Etheridge.)
- 64-H-1. Dermea dieback of Douglas fir. (D. E. Etheridge.)
- 53-I-3. Pole blight of western white pine. (R. G. McMinn.)
- 63-J-1. Deterioration of Douglas fir logs. (R. B. Smith and H. M. Craig.)
- 60-K-2. Systemic fungicides in Douglas fir. (L. C. Weir.)
- 67-K-5. Silvicultural control of Atropellis piniphila. (L. C. Weir.)
- 66-K-2. Physiological impact of treatment of western white pine seedlings with Phytoactin. (A. E. Harvey, Cooperative with Washington State University.)

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## APPENDIX VI-BUSINESS MEETING

## OLD BUSINESS

National Disease Work Conference

Idea of National Disease Work Conference suggested by Alex Shigo was presented by Scharf. Indications were Southern Work Conference may favor this type of session and Northeastern Work Conference definitely in favor. Hepting was against.

General consensus of queries was: (1) 1974 earliest possible meeting date; (2) meetings be set on 10 year interval; (3) work through Phytopathological Society for coordination. Scharf will investigate problem further. A committee will be selected at a later date.

## NEW BUSINESS

## A. Honorary Members

Reed Miller selected and approved.

## B. Financial problems of assembling proceedings:

1. In future, insure that Secretary-Treasure's organization can finance costs involved.

## C. Donations

On motion made by Reed Miller, \$25.00 were donated to Nature Conservancy, San Francisco, in honor of Willis Wagener.

D. Committee Reports

Larry Wier - Disease control committee expanded but reports lacking. Jack Roff and associates agree to be members.

Bob Scharf - Dwarf mistletoe committee suggested combining with the SOLAR function of Intermountain Station for literature retrieval.  
Westurde R&D proposal - possibly financed and centralized at Corvallis - will be complete Work Unit.

E. Announcements

North American Forest Biology Workshop will be held in Corvallis in the spring of 1971.

F. Future Meeting

1971 meeting site suggested for Alaska for week after Labor Day.

1972 meeting site - possibility of Mexico City. This will be investigated by Frank Hawksworth.

## G. Financial Report - Presented by Jack Roff

## Income:

Previous Balance-----	\$ 281.22	
Registration-----	<u>1115.00</u>	
Total Income-----		1396.22

## Expenses:

Nameplates-stamps-----	\$ 13.40	
Bus (Field trip)-----	97.00	
Lunch (Field trip)-----	97.50	
Banquet and coffee-----	951.00	
Contribution (Nature Conservancy)	<u>25.00</u>	
Total Expenses-----		1183.90

Current Balance-----		212.32
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## H. Participation

Members Registered	Regular-----	58
	Honorary----	4
	Students----	<u>12</u>
	Total-----	74
Ladies Registered-----		<u>25</u>
Total Attendance-----		99
Banquet Attendance-----		88

## APPENDIX VII. -- COMMITTEE REPORTS

## MISTLETOE COMMITTEE

R. F. Scharpf, Chairman

## Highlights of 1969-70 Activities

## I. TAXONOMY, HOSTS, AND DISTRIBUTION

a. The manuscript for a monograph on the biology and classification of Arceuthobium has been submitted to Washington for publication as a USDA Agricultural Handbook. This taxonomic treatment recognizes 32 dwarf mistletoes: 28 in the New World and 4 in the Old World. The 28 New World taxa comprise 24 species, 5 subspecies, and 2 formae speciales. Five dwarf mistletoes are recognized in Canada, 17 in the United States, and 14 in Mexico. Botanical descriptions, drawings, color photographs, and distribution maps are included for each dwarf mistletoe. (Hawksworth, U.S.F.S., Ft. Collins and D. Wiens, Univ. Utah.)

b. As part of our taxonomic studies of Arceuthobium a trip was made in the fall of 1969 to the Dominican Republic, Honduras, Guatemala, and Mexico. Two previously undescribed dwarf mistletoes were discovered: a parasite of Pinus ayacahuite in Guatemala and a parasite of P. oocarpa in Honduras. Arceuthobium bicarinatum of Hispaniola was confirmed to be a distinct species (Hawksworth, U.S.F.S., Ft. Collins and D. Wiens, Univ. Utah).

c. The Douglas-fir dwarf mistletoe, Arceuthobium douglasii, has been found in the Plumas National Forest, about 10 miles northwest of Quincy, California. This locality is about 60 miles south of the previously known southern limit of this dwarf mistletoe in the Cascade-Sierra Nevada range. (D. R. Miller, U.S.F.S., San Francisco.)

d. Douglas-fir dwarf mistletoe was observed in west side stands on the Mt. Hood National Forest. Overstory infections occur on both sides of the Clackamas River in at least eight different sections (T7S, R7E, Sections 25 and 36; T7S, R8E, Sections 30 and 31; T8S, R8E, Sections 6 and 7; T8S, R7E, Sections 1 and 2). This area is approximately 5 miles from the divide at the closest point.

Thus, the conditions for successful infection of west side Douglas-fir are present in substantial areas west of the Cascade Crest, a situation of concern for pathologists and others involved in dwarf mistletoe control. (Knutson, U.S.F.S., Corvallis)

e. A manuscript is in preparation on the mistletoes of California and their control. (Scharpf, U.S.F.S., Berkeley.)

f. Two of several well defined swellings on plantation-grown interior Douglas-fir inoculated with seed of Arceuthobium campylopodum f. tsugensis have produced aerial shoots. At last observation the tallest was 3 mm. This confirms the susceptibility of Douglas-fir to hemlock mistletoe and increases the number of known genera of conifers susceptible to this mistletoe from five to six-- Tsuga, Pinus, Abies, Larix, Pices, and Pseudotsuga.

Larch dwarf mistletoe (A. c. f. laricis) has been successfully established on plantation-grown Abies amabilis. The single confirmed infection has produced aerial shoots up to 15 mm. tall, some with female flowers. (R. B. Smith, Forest Research Lab, Victoria.)

## II. PHYSIOLOGY AND ANATOMY

a. I did a small greenhouse experiment, comparing the effect of high and low light on aerial shoots. Trees were inoculated in a growth chamber and moved to the greenhouse on April 3, 1970.

1. Extension growth from April 3 to June 25 was greater in high light than low (18.1 cm. versus 11.7 cm.). Aerial shoots from both treatments looked healthy, but differed in general appearance. The aerial shoots in high light were long and slender. Those in low light were all shorter with a greater diameter.

2. Each treatment had 7 aerial shoots (on 4 trees) on April 3, 1970. On August 7, 1970, shoot numbers had increased to 22 in the high light treatment but only to 16 in low light.

3. All 7 of the original aerial shoots at low light flowered, producing male flowers. None of the 7 original aerial shoots in high light flowered. (Knutson, U.S.F.S., Corvallis.)

b. Measurements of water potential of lodgepole pine (Pinus contorta) branches and dwarf mistletoe (Arceuthobium americanum) shoots were taken to determine if a water potential gradient existed between them. The pressure chamber technique was used for the determinations, and the reliability of the readings was checked with the dye method. The lodgepole pine water potential (an average

of 22 values) was -14.7 bars, while that of the dwarf mistletoe shoots (an average of 49 values) was -21.3 bars. The observations were used as 22 pairs. A calculated  $t$  value of 12.3 indicated the water potentials were significantly different at the 1 percent level. This finding indicates that the shoots are able to obtain water from their host even when the xylem is under considerable water stress. (Walter R. Mark and C. P. P. Reid, Colo. State Univ., Ft. Collins.)

c. A manuscript is being prepared on the influence of light on the infection of pines by dwarf mistletoe. (R. F. Scharpf, U.S.F.S., Berkeley.)

### III. LIFE CYCLE STUDIES

a. I have developed a methodology of year-around inoculations of young (1 - 12 months) ponderosa pine with seed of Arceuthobium campylopodum f. campylopodum. Seed are stored at 75 percent RH and 1°C, germinated in 2 percent hydrogen peroxide, and placed on young (2 months) pine stems at the cotyledons.

The first obvious signs of infection are a proliferation of adventitious host buds near the point of infection and a swelling of the host tissue. The first aerial shoots invariably emerge at the very point of penetration, although subsequent shoots sometimes come out on the opposite side of the stem. Average time between inoculation date and emergence of the first aerial shoots is 90 - 100 days.

This method provides a steady source of uniform infected material with known history and lends itself to detailed investigations of the infection process and reactions of the host. Additionally, this methodology could be incorporated into a chemical screening program or an outplanting program. (Knutson, U.S.F.S., Corvallis.)

b. Studies were completed on the growth of dwarf mistletoe cankers on different ranks of fir branches. Measurement of random canker lengths and of the apparent growth rate of selected cankers showed that dwarf mistletoe grew fastest on primary branches, with decreasing growth on secondary and tertiary branch ranks. Fruiting was also greater on primary branch infections than on secondary or tertiary branch ranks. (J. R. Parmeter, Univ. Calif., Berkeley.)

c. A manuscript has been prepared on "Seed production and dispersal by dwarf mistletoe in overstory Jeffrey pines in California." (R. F. Scharpf, U.S.F.S., Berkeley.)

d. Based on observations of tagged seeds, hemlock mistletoe develops rapidly. Flowers may be produced as early as 3 years after seed dispersal and fruit after 4. Most female infections, however, do not bear fruit until the 5th and 6th years. Considering that even vigorous 2-year-old infections would largely remain undetected during sanitation work, only 2 additional years would be required for fruit production. For this reason, recleaning 2 years after initial sanitation should be included in any experimental control trials.

On the average, individually tagged larch mistletoe aerial shoots were longer lived than hemlock mistletoe. Five consecutive crops of female flowers were recorded for one larch mistletoe shoot, four crops occurred occasionally, and three were common. The maximum number of flower crops observed for hemlock mistletoe was three. (R. B. Smith, Forest Research Lab, Victoria.)

#### IV. HOST PARASITE RELATIONSHIPS

a. One-half the spread and intensification plots in Douglas-fir have been installed on the Lolo N.F. The study is similar to the INT Growden study. The study period is indefinite. (O. J. Dooling, U.S.F.S., Missoula.)

#### V. EFFECTS ON HOSTS

a. The spread and intensification plots above are also designed to measure growth loss and mortality due to dwarf mistletoe. (O.J. Dooling, U.S.F.S., Missoula.)

b. Studies on the initiation and development of stem infections on fir were completed. Most stem infections originated from branch infections, and most invasion occurred before the stem segment was 20 years old; but invasion up to 87 years was recorded. The rate of longitudinal extension (sum of both directions) varied from 0.6 to 3.5 cm/yr, with an average of 1.9 cm/yr. Tangential growth varied from 1.1 to 7.0 mm/yr (average 3.3 mm/yr). Growth rate and amount of swell were unrelated to trees or to position in trees, indicating that these are inherent differences among individual mistletoe plants. Only 5 of 68 infections showed decay, and 4 of these were over 70 years old. It was concluded that, in young growth management, it is unlikely that stem infections will result in serious decay or defect problems. (J. R. Parmeter, Univ. Calif., Berkeley.)

## VI. ECOLOGY

a. In an attempt to learn why Arceuthobium americanum has an upper limit somewhat below the upper limits of commercial lodgepole pine, 30 infected seedlings were transplanted into this mistletoe-free zone in 1968. After two winters, 15 trees are still alive but in most cases the dwarf mistletoe shoots did not survive. Although the infections are apparently alive, the shoots are only about 1 mm. high. Dwarf mistletoe fruits did not mature on the transplanted trees in 1968, 1969, or 1970. Attempts will be made to correlate dwarf mistletoe activity with long-term weather data available for the site. (Hawksworth, U.S.F.S., Ft. Collins and J. G. Laut, Colo. State Forest Serv.)

b. All known locations of A. americanum and A. pusillum east of the Canadian Rockies have been mapped preparatory to studies of environmental influences and distribution patterns. Evidence for ecological zonation is being accumulated. The eastward range of A. americanum was extended more than 120 miles by the discovery of it on jack pine at the western end of Lac Seul in Ontario. A report on this infection center by the Ontario Disease Survey staff (Larsen and Gross) is presently in press. (J. G. Laut, Colo. State Univ., State Forest Serv.)

## VIII. CONTROL - BIOLOGICAL

a. A fungus associated with resinosis and girdling of dwarf mistletoe infections on western hemlock has been identified as a species of Nectria. Both the perfect and imperfect stages have been found throughout the range of hemlock mistletoe in B. C. Inoculations with mycelia from ascospore cultures have proven successful in at least two cases as evidenced by heavy resinosis and production of the imperfect (conidial) stage. (A. Funk, J. A. Baranyay, R. B. Smith, Forest Research Lab., Victoria.)

b. Studies on a rust (similar to Cronartium commandrae) associated with lodgepole pine dwarf mistletoe in the Rocky Mountains are continuing. The rust is now known in several areas in Colorado, Idaho, Montana, and Wyoming. Histological studies indicate that rust infections are younger than the mistletoe infections so apparently mistletoe precedes the rust. Life cycle studies of the rust are in progress. The alternate host, if any, is not yet known but the rust apparently will not infect Commandra. (R.G. Krebill, U.S.F.S., Logan and F. G. Hawksworth, U.S.F.S., Ft. Collins.)

c. Studies on the insects associated with dwarf mistletoes were continued. The life cycle of a plant bug (Neoborella tumida - Miridae) was established. It was confirmed to feed on dwarf mistletoe shoots. A spittle bug (not yet identified) was collected for the first time on the pinyon dwarf mistletoe (Arceuthobium divaricatum) at Grand Canyon, Arizona. A paper on the insects and mites associated with dwarf mistletoes is in press and will be published soon as a Research Paper from the Rocky Mountain Station. (R. E. Stevens and F. G. Hawksworth, U.S.F.S., Fort Collins.)

d. A review article is being planned on the "Hyperparasites of dwarf mistletoes." (R. F. Scharpf, U.S.F.S., Berkeley, F.G. Hawksworth, U.S.F.S., Ft. Collins, and Ed Wicker, U.S.F.S., Moscow.)

#### IX. CONTROL - SILVICULTURAL

a. Ten dwarf mistletoe control plots were re-treated after a 3-year period in a 30-year-old lodgepole pine stand in Alberta during the 1970 field season. (Project first reported in the Proceedings of the XVth W.I.F.D.W.C.). An average of 15 percent (range 13-21) of the trees left after the first treatment were visibly infected and treated. Originally the average disease intensity was 30 percent (range 15-41) in these plots (Baranyay, C.F.S., Victoria, B. C.)

b. Control in F.Y. 1970 was conducted by five forests on 5,745 acres by either destruction of residual stands after logging or removal of infected overstory from advanced reproduction with thinning of the reproduction. (O. J. Dooling, U.S.F.S., Missoula.)

c. The second cleaning was completed on a series of plots established in Colorado to evaluate the effectiveness of sanitation in young lodgepole pine stands. The stands were first sanitized 4 or 5 years previously. After the second sanitation, the stands were thinned to recommended regional stocking levels. A progress report on the study will be prepared this winter. (F. G. Hawksworth and T. E. Hinds, U.S.F.S., Ft. Collins and D. Brown, U.S.F.S., Denver.)

d. The Wing Mountain ponderosa pine mistletoe control plots established in 1939 on the Fort Valley Experimental Forest, Arizona (see J. Forest. 52: 350, 1954) were reexamined in 1970. Various combinations of overstory and understory treatments were tested on the 67-acre area. We plan to remove all the overstory trees on the plots in 1971 and concentrate future observations in the young stand (now about 50 years old). Effects of two levels of thinnings on dwarf mistletoe spread and intensification will be evaluated. (P. C. Lightle, F. G. Hawksworth, and M. Weiss, U.S.F.S.)

e. Dwarfmistletoe control was completed on 1,365 acres of ponderosa pine and Douglas-fir in eastern Washington during fiscal year 1969. The DNR has developed what I feel is a good workable dwarf mistletoe control-precommercial thinning contract. It is quite simple and designed on a "write-your-own-contract" basis. Foresters in the field merely use clauses for the contract and it is then sent back to the automatic typewriter and typed out. Thus, errors are minimized. We use the six-point rating system for tree classification and have developed a little table of diameters that is provisional for cutters to use. It is based on the table used in the Southwest regions. Results and acceptance have been good and costs are low. We average \$22 per acre on dwarf mistletoe control. Those of you wishing copies of the contracts could send for them. (Russell, DNR, Olympia.)

#### XI. MISCELLANEOUS

a. A series of 1-day workshops on the distribution, biology, impact, and control of dwarf mistletoes has been planned for six locations throughout B. C. during the period August 31 to October 2. The workshops will be comprised of a morning illustrated seminar and an afternoon field trip to nearby infected stands. Forest managers, foresters, and technical staff with supervisory responsibilities have been invited. (J. A. Baranyay, R. B. Smith, Forest Research Lab., Victoria.)

b. Studies on the association of Phoradendron with attacks of Scolytus ventralis on fir indicated that heavily mistletoed trees were attacked in preference to healthy trees. Broods seldom matured in such trees, however, and it appears likely that Phoradendron reduced the total Scolytus population by inducing frequent but unsuccessful attacks. (Leonard Felix and J. R. Parmeter, Univ. Calif., Berkeley.)

c. The complete Hawksworth Mistletoe Index is in the process of being put on computer tape for "Famulus" retrieval. A third of the Index (about 1,500 citations) is now on Famulus tape and the remainder should be incorporated into the system and ready for use by 1971. (F. G. Hawksworth, Ft. Collins, R. F. Scharpf, Berkeley, and Ed. Wicker, Moscow, U.S.F.S.)

## STATEMENTS ON THESIS PROJECTS

## Ph.D. Projects

a. Resin disease of lodgepole pine dwarf mistletoe. Objectives: To investigate the cause, epidemiology, and biological control potential of this fungus disease of lodgepole pine dwarf mistletoe in the central Rocky Mountains. Walter Mark, Colo. State Univ. Advisors: N. Oshima and F. G. Hawksworth.

b. Physiology of ponderosa pine dwarf mistletoe. Objectives: To investigate the physiological relationships of ponderosa pine dwarf mistletoe and its host in Colorado. Emphasis will be on water relations as they affect distribution and abundance of the parasite. James Fisher, Colo. State Univ. Advisors: C. P. P. Reid and F. G. Hawksworth.

## Master's Projects

a. Effects of dwarf mistletoe on wood properties of lodgepole pine. Objectives: To determine the effects of dwarf mistletoe on specific gravity, fiber angle, tracheid length, strength (modulus of elasticity, modulus of rupture, work to proportional limit, work to maximum load), longitudinal shrinkage, and proportion of spring vs. summer wood. Douglas Piirto, Colo. State Univ. Advisors: H. E. Troxell and F. G. Hawksworth.

b. The vertical spread rate and intensification of dwarf mistletoe in hemlock. The vertical rate of spread of dwarf mistletoe was studied in two actively growing, young hemlock stands. This was done by determining the height and age of successive oldest and highest female infections. The rate of spread was calculated by summing the heights of advances and dividing by the total number of years lapse between successive advances.

The mean vertical spread rate in a relatively open stand was  $2.1 \pm 0.1$  ft./yr. and in a relatively dense stand was  $1.0 \pm 0.1$  ft./yr.

The mean rate of tree growth from release of suppression in the open stand was 2.5 ft./yr. and for the dense stand was 1.5 ft./yr. However, over the past 25 years, the growth rate of the trees in the open stand was 1.9 ft./yr. and for the dense stand 1.1 ft./yr.

An investigation of the rates of intensification revealed that the number of new infections per year increased geometrically, doubling every 4 years in both the dense and open stands. However, the geometric increase levelled off 6 years ago in the open stand and 5 years ago in the dense stand.

The results of the investigation indicate that during the maximum growth phase of hemlock in an open or dense stand, the most photosynthetically active upper portion of the crown remains free of mistletoe infection. Until the senescent phase is reached, the trees can be expected to outgrow the mistletoe and intensification will be restricted to the lower portions of the crowns.

It is tentatively concluded that provided there is no overstory seed source and no disruption of the natural stand, such as thinning, dwarf mistletoe on hemlock will not become serious until the rate of height growth of the trees falls below the rate of vertical spread, i.e., not until after the presently accepted rotation age.

K. S. Richardwon. UBC. Vancouver, Canada.

HIGHLIGHTS OF THE FOREST DISEASE CONTROL COMMITTEE  
THIRD ANNUAL REPORT

Results of Disease Control Tests - 1970

1. Chemical -

A. Control of Annosus Root Rot in Douglas Fir and Western Hemlock

(1) Screening tests using small circular discs of freshly-cut Douglas fir and western hemlock indicated effective action of some chemicals against stump infection by spores of F. annosus. These chemicals were zinc chloride, sodium carbonate, copper sulphate, zinc sulphate and acetic acid. Applications of chemicals and inoculation with basidiospores of F. annosus were made in May 1970 and results are expected in October 1970. (Weir)

(2) Control of Western Gall Rust in Monterey Pine Planted on the Oregon Coast

Several chemical formulations involving stove oil resulted in death of the causal fungus when applied directly to severely scarified galls. Killing of the host tissue by the treatment was probably the primary reason for the death of the fungus. Consequent exposure of sapwood in the treated area to colonization by wood rotting organisms may be even less desirable than the galls. (R-6, U.S.F.S.)

(3) Borax was effective in preventing Fomes annosus colonization of fresh-cut ponderosa and Jeffrey pine stumps in California. Less than two percent of the borax-treated stumps became colonized four weeks after artificial inoculation with F. annosus. Over 50 percent of the untreated control stumps similarly inoculated and examined became infected. These data will be used to get USDA Registration for this use of borax on western pines. Currently, it is registered for this use only on eastern pines. As soon as registration is obtained, borax will be recommended for treating fresh-cut pine stumps in certain high-risk, high-value California areas. (Graham)

## 2. Biological -

## A. Control of Annosus Root Rot in Douglas fir and Western Hemlock

- (1) Screening tests as A(1) with a number of stump-inhabiting fungi indicate some degree of protection against infection by basidiospores of *F. annosus*. Field tests have been established and will be sampled in March, 1971. (Weir)

## DISEASE CONTROL COMMITTEE BUSINESS MEETING

A meeting of the Committee resulted in an expressed wish to expand the report to include experiments in process as well as those that are terminated. Further discussion led to the feeling that requests for disease control information should be more general than is presently the case. As a direct result, committee members in each region including the universities will be asked to locate and submit to the chairman all information that can be collected. An appeal is being issued to all conference members to support these requests with prompt responses.