Proceedings of the Eleventh Western International Forest Disease Work Conference
Jackson, Wyoming September 1963

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FOREWORD

The eleventh International Forest Disease Work Conference was held from September 9 - 13, 1963, in Jackson, Wyoming. Sixty-six members and guests registered for the conference which was held in the Wort Motor Hotel. The chairman, C.G. Shaw, opened the meetings with an intoductory address (with careful notation of the actual location of this conference !) He was followed by the Mayor of Jackson, H.E. Clissold, and Floyd Iverson, Regional Forester who welcomed members to the area.

The full conference-room program was supplemented by a Field Trip Day on Thursday, September 12, which began when members gathered at the Curtis Canyon Viewpoint for an open-air talk by H.H. Van Winkle on "Multiple Use Administration on the Teton National Forest". This was followed by a visit to the Gros Ventre slide. Lunch was "Chuckwagon Style" at a genuine western Dude Ranch, and in the afternoon R.S. Peterson conducted a Comandra rust tour.

The Banquet at the Wort Motor Hotel was attended by 80 members and guests. Alec Molnar won the W.I.F.D.W.C. award in the face of fierce competition. The presentation of the ladies' award to Mrs. Wagener was enthusiastically applauded by all.

The business meeting and adjournment took place on the afternoon of Friday, September 13, 1963. Members agreed to hold the 1964 meeting in Berkeley, California.

Executive Committee

C.G. Shaw - Chairman
J.E. Bier - Secretary Treasurer

Chairman of Program Committee

R.F. Scharpf.

Co-ordinator of Local Arrangements

Lowell Farmer

It is mentioned that the Secretary-Treasurer has played a very minor role in the preparation of this report. Grateful acknowledgement is given to Trudy Pentland, Mollie Byrne, and (Mrs.) O.E. Fawkes, for the excellent cooperation, initiative and effort in this regard.

CHAIRMAN'S REMARKS

C. G. Shaw

Ladies and Gentlemen - Welcome to the Eleventh International Forest Disease Work Conference.

Irrefutable proof has already been provided that these meetings are being held in Jackson Hole, Wyoming. Perhaps, however, you had better wait until Jack Bier, with Miss Trudy Pentland's help, has prepared the formal proceedings of this meeting before reaching any final conclusions as to just where you are this morning. Georgraphical transpositions can occur all too easily, let me assure our Canadian colleagues. You may find when you receive the proceedings that you were supposedly in Woods Hole, Massachusetts or possibly Jackson, Mississippi.

Last year's meeting completed the first decade of the history of our organization. The proceedings for the ten meetings already held make an imposing volume when bound as a single unit.

With this meeting we start the second decade of our history. The success of W.I.F.D.W.C. will continue to be measured, not by the thickness of each issue of the proceedings but by the stimulation and ideas that each of us carries away as a result of actual participation in our sessions.

As in the past, the success of our conference will depend on the participation of each of us whether we present a formal paper or not. Indeed, if the time should come when everyone who has something to contribute must be allocated 10 minutes in which to say it, and the subsequent discussion limited to 20 seconds, W.I.F.D.W.C. undoubtedly will disband by common consent of it's members.

Our program has been organized by Bob Scharpff with the able assistance of Clancy Gordon and John Hopkins. If as this conference progresses, areas of interest to you are not discussed, please make this fact known to the interim program chairman, Mr. Joe Baranyay. In the next several days he will solicit your comments and suggestions for next year's program.

Our thanks are due the committee on local arrangements for their efforts to make this conference a success. The committee headed by Lowell Farmer included: Mr. H.H. Van Winkle, Mr. Jim Kimmey and Mr. Don Leaphart.

I'd like to call now on one member of this committee, Mr. Rip Van Winkle, to present our honored guest, the mayor of Jackson Hole, Wyoming, Mayor H.E. Clissold.

ADDRESS OF WELCOME

Floyd Iverson.

Mr. Chairman, Mayor Clissold, ladies and gentlemen of the Conference, and friends:

It is a pleasant experience for me to have this opportunity to welcome you to the Intermountain Region as you open your eleventh annual conference. I have personally been acquainted with some of you for many years and have thus been able to keep posted on a few of your many interesting and important fields of endeavor. For the most part, it is true that we have known you mostly by your good works. We have profited materially from this knowledge because you have pinpointed for us the "hot spots" in the forest disease problem areas. It is an added dividend to see you here and to greet you and talk with you personally.

We are gathered in an area dating back into the earliest history of forest conservation. The Yellowstone Park Timberland Reserve, now part of the Shoshone, Teton, and Targhee National Forests, was the first one created in the United States. The proclamation was approved by President Harrison, March 30, 1891. President Grover Cleveland created the Teton Forest Reserve, now the Teton National Forest, by Executive Order on February 22, 1897.

Today the Teton National Forest embraces over 1.7 million acres which, together with Grand Teton and Yellowstone National Parks, span the headwaters of the Nation's main waterways, flowing into both the Pacific and the Atlantic Oceans. These physical factors, plus the widescale recreational opportunities and scenic values both in the nearby National Parks and the National Forests, present the ideal combination of features that add up to Jackson Hole. This is indeed a land which possesses very richly all the multiple resources-- a land where recreation, water, timber, forage, and wildlife are abundant. The wealth of timber embraces and fosters all the other resources and in this important role requires careful management, protection and use.

Forest Supervisor Van Winkle will describe for you Thursday, as a part of your field trip, the challenges and problems he encounters daily in managing and protecting the resources of the Teton National Forest. He will give you in more detail as it applies here in Jackson Hole the meaning and intent of Forest Service administration for the greatest public benefit under the Multiple Use Act of June 12, 1960. I know of no better place to show you all its facets.

To acquaint you briefly with the Intermountain Region, let me say first that we have 18 National Forests; two in Nevada, with a portion in the Sierra Nevadas of California; seven in Utah; seven in

Idaho, south of the Salmon River; and two in Western Wyoming -- about 31 million acres.

Commercial forests cover over nine million acres of these National Forests, or about a third of the total area. They embrace $58\frac{1}{2}$ billion board feet of sawtimber and 2.4 million cubic feet of other forest products. I give you these figures to use as a means of measuring our Region as against other areas from which you have come. Many of you are from areas where such figures are small by comparison. Equally as many, however, are from areas supporting similar or even lesser amounts.

As you already know, the problems of disease, along with many others, can be equally as challenging regardless of the economic factors or the size of your workshop. Disregarding the size of the forest, the bite taken by disease has the same impact ratio, other factors being equal.

The Intermountain Region is, and will remain for a long time, a timber-importing Region insofar as production from National Forests is concerned. Our 1962 cut provided about 200 board feet per capita, whereas our present Intermountain per capita timber consumption is 250 board feet annually. As a partial remedy, and as a long term objective, we expect to raise the timber production capacity of these lands. We feel that they have a capacity of at least 225 board feet per acre per year, whereas they are now producing only about 110 board feet per acre per year. A large share of the increase will develop from the removal of old growth and overmature timber resulting in better growing conditions. We realize that only when production factors are tempered with adequate protection can the full capacity of any forest lands be realized. In this latter regard it has been well demonstrated that underproduction or nonproduction created by forest disease can easily place a timber property either on an "in-the-red" or on a "breaking-even" basis. Today's forest economics do not tolerate for long such an impasse . Publicly-owned forests merit great concern because of the infinitely wide and exacting demands of multiple use forestry.

Disease, as you are all aware, is presently ranked by the most recent survey report titled, "Timber Resources for America's Future," as the leading enemy of timber production in the United States. I assume that our neighbors to the north in Canada and to the south in the Republic of Mexico could repeat such a statement for their respective countries. Neither foresters nor forest pathologists, I am sure, are about to accept such a fact as a static condition. We want to correct the situation. It should constitute as resounding challenge to our professional skills. It should be a springboard for our multifold contributions toward improving the management of forested lands. Such information should comprise the background for a widescale program to gain public understanding and support. Herein lies one of the keys to progress in a democracy.

In some of the phases of protection and management with which you are concerned, this Region has, I am sorry to say, been lagging. Many of you might be compelled to make a similar statement when speaking in terms of applied management or control practices to reduce the incidence of disease. Part of the problem is that we have not had the technical personnel and guidance needed to advise us in these complex fields. Research is still in the preliminary phases on many of the more serious diseases now requiring management action. This is not strange, for the problems created by disease are as complex, variable, and numerous as the forest types, sites, and species found extending from the desert-lands of southern Utah and Nevada to the thickly timbered areas along the headwaters of the Snake and the Salmon Rivers; or from the Sierra Nevadas to the Rockies.

Dwarfmistletoe, of which we have no less than ten species and forms in the Region, is costing us untold production. We recently learned, for example, that at least a third of the timber stands on the Salmon National Forest is infected. One-third of the timber production on a National Forest not up to par is quite a loss. We may assume from observation that more-or-less similar conditions exist on most of the National Forests in the Region. This represents only one disease out of twenty or more serious tree diseases in the Region.

Comandra blister rust, which you will see during your field trip, has become a major concern since it first came to our attention in 1934. We know much less about it than we do about dwarfmistletoe, which though costly to control may surely be eradicated on limited areas under our present system of operation. What is the future in lodgepole pine management if no suitable control appears in the immediate future for comandra rust?

Fomes annosus rot, too, is reported well on the way to being classed among our major problems. I am happy to see a discussion on this destructive organism included on your agenda.

Amidst such an array of serious impediments to Forest production, we have become aware of our past deficiencies in the pathological aspects of forest management. On the bright side, we are gratified that the field of forest pathology is receiving greater recognition than ever before. I recognize that your organization is a leader in bringing about these changes as part of its overall program. You are to be commended on this important contribution to forestry in the West and, as such, in America.

It is a forester's obligation to so manage the lands under his administration that they will return the highest dividends to the owner. In the case of the National Forests, these dividends are paid in dollars and cents into the U.S. treasury for forest products sold, and, in addition, under the multiple use principle they are paid through the perpetuation of all the resources into the centuries ahead. They are also paid to the public by having an ever-present and dependable supply of usable water, an undamaged habitat for wildlife and fish, outdoor recreation and scenic areas in profusion, rangelands suitable to support forage for some livestock needs, and all embraced by the timberlands. These are the multiple values commended to our protection and management, and until we have the knowledge to give them singly or collectively the management they warrant, they are our problems.

In closing, may I say that I hope your brief stay in this area will be as gratifying to you as your presence here is to us. We urge too that you will not, in the future, make it such a long time between visits. You will always be made welcome here either individually or collectively. I am sorry that Director Pechanec of the Intermountain Forest and Range Experiment Station could not be here today to add his greeting to mine. I understand that he does plan to be here later in the week.

Thank you Mr. Chairman, and ladies and gentlemen.

LIMB RUST FUNGI

R.S. Peterson

Summary:

Limb rust is a disease of hard pines in which branches are progressively killed as the causal fungus spreads throughout an infected tree. The fungi causing limb rust may be conveniently (but not realistically) considered in the following temporary categories:

1. Typical Peridermium filamentosum. Alternates to Scrophulariaceae. On Pinus ponderosa var. scopulorum, P. ponderosa var. arizonica, and (in Mexico) other pine species. Occurs northward to Wyoming and South Dakota.

2. Dixie *Peridermium*. Indistinguishable on pine from *P. filamentosum*. Fails to infect Scrophulariaceae, and may go from pine to pine: Mielke got one inoculation "take". On *Pinus ponderosa* var. *scopulorum* in Utah, and maybe elsewhere.

3. Inyo *Peridermium*. Superficially similar to No. 1 and No. 2, above, but lacks their abundant aecial filaments. Sporulates in late summer, unlike the May-June sporulation of No. 1 and No. 2. Fails to infect Scrophulariaceae; life cycle unknown. On *Pinus jeffreyi* in central and southern California.

4. Washoe *Peridermium*. Morphologically resembles (and may be) *Peridermium stalactiforme*. Causes cankers (bark roughening) on stems as large as 10 cm. in diameter, as well as causing limb rust. On *Pinus jeffreyi* in California and western Nevada; mostly further north than the Inyo *Peridermium*.

We are trying to work out the life cycles, taxonomy, and host ranges of these fungi by inoculations and by study of specimens.

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"REMARKS ON THE BOTANICAL CODE"

"WESTERN GALL RUST"

These brief, informal talks were also given by R.S. Peterson, but no paper was prepared.

WESTERN HARD PINE RUSTS, PERIDERMIUM STALACTIFORME, CRONARTIUM COMANDRAE, C. COMPTONIAE, and C. CONIGENUM

H. Zalasky

In Saskatchewan and Manitoba I am familiar with three rusts *Cronartium comandrae*, *Peridermium harknessii* and *P. stalactiforme*, all on *Pinus banksiana*, *Myrica gale*, or *Comptonia asplenifolia* in the two provinces. However, Weir and Hubert collected a few specimens of what they presume to be the aecial state of *Cronartium comptoniae* on *Pinus banksiana* indicated in the table by Spaulding and Hansborough (1932), but this identification was not confirmed by inoculation experiments.

I shall present a brief review of the literature on taxonomy, life cycle and symptomatology of *Peridermium stalactiforme*, *Cronartium comptoniae*, *C. comandrae*, and *C. conigenum*.

Peridermium stalactiforme Arth. & Kern

Taxonomy:

Arthur and Kern (1906) described *Peridermium stalactiforme* from a type specimen collected on *Pinus contorta* in Washington. Since 1906 there has not been any critical taxonomic work on this rust. Arthur (1922) made a new combination *Cronartium* Arth. & Kern and cited *Peridermium stalactiforme* Arth & Kern as its synonym. However, *Peridermium stalactiforme* is an imperfect state which cannot be validly transferred to, i.e., made the type of the name of, its perfect state, the *Cronartium* (Art. 57). Without the accompanying uredinial and telial description, the binomial, *C. stalactiforme* as synonyms of *Cronartium coleosporioides* (D.& H.) Arth. which has no known aecial type specimen.

The original paper on *Peridermium stalactiforme* by Arthur and Kern (1906) contains the aecial description only. Mielke (1952) used the electron microscope to study aeciospore morphology and found the processes are usually prominently annulated; annulations generally obtuse serrated in outline; tops of processes generally roundish, more coursely serrated than *P. filamentosum*. Silhouettes of *P. filamentosum* and *P. stalactiforme* aeciospores are fairly similar at magnifications 1,500 diameters. Also at this magnification some of the processes may appear similar in shape. It is not until much higher magnifications are employed and individual processes examined, however, that differences among them become apparent. A magnification of 25,000 clearly illustrates differences in size and shape of the processes.

In Saskatchewan *Peridermium stalactiforme* has two known alternate hosts, Melampyrum lineare and Castilleja rhexifolia, which have been tested in the field and greenhouse by Zalasky and Riley (1962). These inoculation experiments have shown that the developmental cycle of urediniospores, which take 14 days to mature, is two days earlier than that of teliospores, which take 16 days to mature. This serves as an important basis for future taxonomic work in P. stalactiforme.

In the Pacific coastal and Rocky Mountain regions the two principal aecial hosts of this rust are Pinus banksiana, and P. contorta ; other are P. jeffreyi and P. ponderosa. According to the distributional records published by Peterson (1962), P. stalactiforme occurs on Pinus contorta in central Coloradao and California, Nevada, Utah, Wyoming, Eastern Washington, Idaho, and Montana; and on P. ponderosa in Colorada and Western South Dakota. It is also known to occur on P. contorta in Alberta and British Columbia. The uredinial and telial states occur on Castilleja miniata: whereas, on Castilleja angustifolia, C. coccinea, C. linearis, and C. rhexifolia, the uredinial and telial states are known from inoculation studies only; and on Melampyrum lineare they are known in Minnesota, Saskatchewann and Quebec. An accurate list of alternate hosts from field records in the Pacific coastal and Rocky Mountain regions is not available. However, there remain a large number of alternate hosts to be tested.

Life Cycle:

Host alternation appears to be obligate. Air-borne basidiospores from late June to fall infect susceptible pines. Pycnia are produced in the spring. The exudate contains pycniospores, which presumably function as spermatising agents. In Saskatchewan, aecia mature in the first week of June and are produced until the first week of August. Aeciospores infect Castilleja rhexifolia and Melampyrum lineare. Mature uredinia and telia are produced last week of June to first frost in the second week of September. Urediniospore infections are repeated on the alternate hosts. Teliospores are capable of germinating readily. The basidiospores are carried by air currents to nearby susceptible pines.

Symptomatology:

It has been reported that aecia normally show up on diamond-shaped areas or in longitudinal streaks of slight swellings of small stems and branches and are quite conspicuous in spring. On trunks of older trees the symptoms are quite different; the fungus causes elongate, often sunken cankers up to 30 feet long, usually accompanied by resinosis. Aecia at the margins of these cankers are sparse, inconspicuous, or totally absent. Resinosis and dearth or lack of aecia are attributed mainly to rodents that habitually feed on the succulent callus tissues of the cankers and the pycnial exudate of the fungus.

CRONARTIUM COMPTONIAE ARTH.

Taxonomy:

Arthur (1906) first described the uredinial and telial states of the rust, and named the rust Cronartium comptoniae. For a long time this rust was confused with C. comandrae. Several investigators successfully inoculated Comptonia asplenifolia and Myrica gale with aeciospores from pines obtaining Cronartium comptoniae upon the infected leaves. Orton and Adams (1914) proposed the name Peridermium comptoniae to the aecial state without description of the type. The pycnia and aecia were described by Arthur (1925).

Since Cronartium comptoniae is very similar to other stem rusts in aecial morphology and in symptomatology, knowledge of the telia hosts becomes necessary. It can be obtained by artificial infections of a telial host with aeciospores of the pine rust.

The principal hosts are Pinus contorta, P. ponderosa, Comptonia peregrina, and Myrica gale; other hosts are Pinus coulteri, P. jeffreyi, P. muricata and P. radiata. It is reported that the distribution of this rust in the Pacific Coastal and Rocky Mountain regions is from Alaska to Northern California. I have not been able to examine more distributional records other than that of Spaulding and Hansborough (1932).

Life Cycle:

The periodicity of development of pycnia, aecia, uredinia, and telia is not completely worked out. Infection of young pine seedlings becomes evident usually in their third year. The pycnia must be formed early in their second year, as they are definitely known to precede aecia. The aecia usually appear in the third year. Aeciospores are wind-borne and infect Comptonia or Myrica; they germinate promptly if there is some water present on the leaves. The infection by an aeciospore must develop 8 to 12 days, after which time mature uredinia form under favorable conditions. After an interval of about 30 days the uredinial spots produce telia. The telia develop basidiospores which are readily distributed by wind. According to Weir and Hubert (1917) uredinia were noted after 17-21 days and telia after 30-31 but there is no indication whether these were mature fruiting bodies.

Symptomatology:

Small trees 2 to 7 years old are attacked near the soil surface. A slight swelling of the affected twig or stem develops. On trees several inches in diameter an elongated canker or depressed streak develops checking the growth on the affected side of the tree and on each side of the canker a decided ridge is formed. Sometimes the affected part is killed and considerable resin flow and bark thickening is trimulated to form a conspicuous mass. The disease is often confused with that caused by filamentosum rust, and stalactiform rust.

CRONARTIUM COMANDRAE PECK.

Taxonomy:

The first list of synonyms for this rust was published by Arthur (1907), the second by Hedgcock & Long (1915), the third by Arthur (1925) and the fourth in Arthur's Manual of Rusts (1934). Upon examining the reference cited in Arthur's Manual of Rusts for Cronartium asclepiadeum thesii Berk., I find that thesii is a variety described and published by Rev. Berkeley (1845), but the binomial was published by Kuntze. The reference cited for Cronartium thesii Lagerh. was not available. C. asclepiadeum Kuntze var. thesii Berk. occurred on Thesium umbellatum (now Comandra umbellata) collected in Ohio by T.G. Lea, No. 205. Peck (1875) described as a new species, Peridermium pyriforme, a caulicolous Peridermium with obovate to pyriform spores from a specimen collected by J.B. Ellis (No. 2040). According to Hedgcock and Long (1915) this specimen appears to be Peridermium comptoniae and not a true P. pyriforme originally described by Peck. Arthur and Kern (1906) described as P. pyriforme Peck what is now known as P. comptoniae. Arthur and Kern (1914) formally admitted this error and made a correction of their earlier interpretation of P. pyriforme. Peck (1879(published a brief description of what appears to be the uredinial state of Cronartium comandrae on Comandra pallida and C. umbellata in Colorado. Cultures establishing the connection of the alternate state were made by Hedgcock and Long in 1914, by using aeciospores from Pinus ponderosa and sowing on Comandra umbellata. The authors used the specific epithet of Peck's imperfect state and made a new combination, Cronartium pyriforme. Hedgcock and Long (1915) published a technical bulletin on the taxonomy and life cycle of the fungus. The aecial characters are taken from the specimens on Pinus contorta, P. ponderosa and P. pungens; the uredinial and telial characters are taken from specimens of the fungus on leaves of Comandra umbellata obtained by inoculations with aeciospores from Pinus pungens from Pennsylvania. Arthur (1907) accepted Peck's binomial Cronartium comandrae, but in 1925 he reduced it to synonymy and substituted Cronartium pyriforme (Peck.) Hedge. & Long. However, in his Manual of Rusts (1934), he reinstated the name Cronartium comandrae Peck. The latter name was not accepted by Hedgcock, Long and Hunt.

Hedgcock and Long (1915) observed certain differences in size and shape of the aeciospores; these differences may be due to the influence of the aecial host. In specimens of the rust on Pinus contorta from Colorado, some of the aeciospores are very short and slightly accuminate, while many are ellipsoid and even globoid. In specimens on Pinus pungens from Pennsylvania many of the spores are nearly twice as long as those from P. contorta, the accumination is very marked, and the spores are rarely ellipsoid.

The rust occurs on Pinus banksiana, P. contorta, P. jeffreyi, P. ponderosa, P. sylvestris, Comandra livida, C. pallida, and C. umbellata. Its range of distribution is from Yukon southward to California and New Mexico.

Life Cycle:

The life cycle is imperfectly known. Pycnia and aecia occur on pines; uredinia and telia occur on Comandra spp. Pycnia probably serve in sexual fertilization. In Saskatchewan aeciospores are produced from late May to the end of July. Urediniospores and teliospores are produced in June to fall. In 8 to 10 days from the time of inoculation by aeciospores the uredinia appear on the leaves of the infected plants and urediniospores begin to be produced. Each generation of uredinia is followed a few days by one of telia. Telial colums develop in about 15 days. The teliospores germinate as fast as they mature. The basidiospores are wind-borne and readily infect the younger part of pine trees.

Symptomatology:

One pine, Comandra rust causes slight spindle-shaped swellings, followed by exfoliation of the infected bark. Small branches or stems are usually girdled quickly, death following in one or a few years. Where the fungus infects large branches or trunks, elongate cankers are formed. These are often ringed by red-orange pycnial droplets surrounding the red-orange aeciospores in white sacs. However, rodents frequently remove nearly all infected bark, so that spores may be few or lacking. Copious resin flow from such wounds is common. In badly infected Comandra plants, there is a decided stunting of stems and leaves, accompanied by a slight chlorosis of the leaves.

CRONARTIUM CONIGENUM (PAT.) HEDGC. AND HUNT

Taxonomy:

Patouillard (1896) described the new species Caeoma conigenum on the hypertrophied cones of an undetermined species of pine from a specimen collected by Maury in Mexico, June 1891. He published a picture of a diseased and healthy cone of what is believed to be Pinus chihuahuana Engelm. Hedgcock and Hunt (1922) were able to obtain fresh specimens collected in Arizona, and two fragments of the type specimen, one through the courtesy of Prof. Arthur and the other from Dr. Seaver of the New York Botanical Garden. They were able to prove that Patoullard's rust was identical with the Arizona rust, and both were peridial, therefore belonging to a Peridermium. By a series of inoculation tests they were able to establish the relationship of aecial stage on pine with the uredinial and telial states on oak. They described Cronartium conigenum as new species and cited Caeoma conigenum as a synonym. The pycnia were described from F.P. No. 25402, collected by N.R. Hunt, Sept. 28, 1918, the aecia from F.P. No. 36152 collected by O. Shoenberg, Aug. 10, 1920 both on cones of Pinus chihuahuana and the uredinia and telia from F.P. No. 29666 on the leaves of Quercus hypoleuca collected by N.R. Hunt. Sept. 28, 1918, all collected near Portal, Arizona.

Arthur (1932) transferred both Caeoma conigenum and Cronartium conigenum to Cronartium quercuum (Berk.) Miyabe in Shirai. Hedgcock and Siggers (1949) did not accept Arthur's decision and stated, "there is much need for clarification of the taxonomic position of the pine-oak rusts, one must entirely ignore the differences in the form of aecial fruiting, the fact that the species maintain their distinct aecial forms, and that it is not possible to obtain one aecial form with cultures from another. In the manner and time of fruiting, the species are distinct not only in their pycnia and aecia but also in their uredinia and telia." May I add to the above, a species may be similar to another species but it is not necessarily identical. Therefore, I do not believe that Arthur's transfer is valid.

The destribution is not well defined but the fungus is known to occur in the mountains from Arizona through Mexico and Guatemala. The principal hosts are Pinus leiophyllavar. chihuahuana, P. leiophylla, Quercus arizonica, Q. emoryi, Q. hypoleuca and others. A large number of species of oak are known to be hosts by inoculation tests.

Life Cycle:

The rust is heteroecious. Pycnia and aecia occur on pines, and uredinia and telia on oak leaves. Pycnial fruiting is biennial, occurring May to June; aecial fruiting is also biennial, occurring June to July. From artificial infection of two seedlings of Pinus caribea by Hedgcock and Siggers (1949), pycnia developed on one seedling is 140 days, and in 325 days on the second seedling. Both trees died before aecia were produced. Uredinia are produced all year, whereas telia are produced June to July. The period for uredinial development is 11 to 14 days. The time of telia formation was extremely variable, depending on the season of inoculation. Spring and summer inoculations resulted in successive generation of urediniospores, with telia delayed as long as 300 days; in late fall, telia often appeared in about 80 days.

Symptomatology:

As a result of infection cones develop into galls having a slight differentiation of the surface into scales and very little resemblance to a true cone. The immature galls are usually two or more times larger than cones of the same age and regardless of size may be sliced up with a knife much more readily than healthy cones. After fruiting the galls dry up and remain on the trees as mummies. The interior of these mummies is nearly always destroyed by insects, so that little more than a brittle shell remains after a couple of months. A striking feature is the great variation in the size of galls, the largest having a volume ten times that of the smallest. The largest galls have a much smoother surface than the smallest ones. On oak leaves the color of the leaf spot is pale green.

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PROBLEMS IN THE CLASSIFICATION OF *CRONARTIUM* AND *MELAMPSORA* RUSTS IN THE LIGHT OF RECENT DISCOVERIES

W.G. Ziller

Introduction:

Perhaps the main reason why so much confusion still exists in the classification of *Cronartium* and *Melampsora* is that so many species of these genera are still not known sufficiently. Rust fungi have entered into an intimate and highly specialized relationship with their host plants during their evolution. This relationship varies greatly between various rusts and can therefore be used as a distinguishing characteristic in taxonomy. Unlike for autotrophic and saprophytic plants, criteria for the classification of rust fungi should therefore not consist only of morphological data, but should include data on life cycles and host ranges as well as host symptoms. Such data must, or should, be obtained from inoculation experiments.

Cronartium:

The dearth of knowledge in our *Cronartia* stems mainly from the time required to carry out appropriate inoculation experiments; it takes years before results of pine inoculation can be evaluated.

Suitable methods of inoculation must be found by experimentation. It is therefore not surprising that a monographic treatment of the Cronartia has not been attempted.

In two of the preceding papers our present knowledge, or lack of knowledge, of the following more or less closely related "species" has been pointed out:

- western gall rust (Peridermium harknessii J.P. Moore),
- Stalactiform rust ("Cronartium stalactiforme", nomen nudum),
- typical limb rust ("Cronartium filamentosum", nomen nudum),
- Dixie peridermium (Peridermium sp.),
- Inyo peridermium (Peridermium sp.), and
- Washoe peridermium (Cronartium sp.).

In addition, a white-spored form of "C. stalactiforme", with hyaline aecio- and urediniospores, has been discovered and studied experimentally.

I have inoculated Indian paint brush (Castilleja sp.) with aeciospores of each one of these seven rusts. With the exception of the white stalactiform rust, my results showed nothing new, only confirmed the results by previous workers and yielded good material, some of which might be suitable for type specimens.

Much information has been gained on these rusts recently, but it is still far from sufficient to distinguish them clearly from each other and to classify them on a comparative basis.

Melampsora:

Melampsora rusts of pine were not known to exist on this continent until quite recently. Briefly, the following discoveries were made since 1960:

Ponderosa pine seedlings in a nursery in central B.C. were found to be infected with Melampsora rust. The rust was first believed to be Melampsora pinitorqua, introduced to this continent from Europe, but later it was proven by Molnar (6) to be M. albertensis, the same rust which infects Douglas fir. Subsequently, it was proven by controlled inoculation experiments that not only M. albertensis but also M. occidentalis and M. medusae infect pine; and not only ponderosa pine, but also six other species of pine, including sugar and western white pine.

This year, inoculation experiments were designed and initiated on an international scale. Their two main objectives are:

(a) To test economically important conifers for their susceptibility to poplar rusts occurring in each of the following regions of the world: Italy, Japan, eastern Argentine, and western Canada.

(b) To review the taxonomy, host ranges, and geographical distribution of poplar rusts on a worldwide basis in the light of experimental results, regional observations, and specimens obtained in (a), above.

My collaborators on the project are: Dr. A. Biraghi, Florence, Italy; Dr. N. Hiratsuka, Tokyo, Japan; and Mrs. E. von der Pahlen, Castelar, Argentine.

The experiments for western Canada are now completed and results from them will be presented in a paper, the manuscript of which is under review (10). So far, the results from the experiments show that conifers belonging to six genera are susceptible to Melampsora rusts native to western North America. Twenty-six new world host records are established. Similarity in host range and host reaction indicate close phylogenetic affinity between Melampsora albertensis, M. medusae, and M. occidentalis.

The result most interesting to a taxonomist is the similarity of the three so-called "species" of Melampsora. The experimental results showed no significant difference between the three rusts in morphology, host range, host reaction, life history, or other taxonomic criteria, with the exception of M. occidentalis. This rust differed distinctly from the other two, but only in spore size and telial host range. Larch, Douglas fir, and several species of pine proved to be most susceptible to each of the three Melampsoras. Most test plants used in the experiments were young seedlings, but up-to-five-year-old plants of western larch, ponderosa and lodgepole pine, and Douglas fir became infected also, larch most severely.

No attempts in reclassification of the poplar rusts will be made until results of the experiments carried out in Italy, Japan and Argentine are available.

(Presentation of color slides of Cronartia and Melampsorae)

Problems in Classification:

International agreement on the meanings of taxa we use for classification seems to be of primary necessity and importance.

To appreciate and summarize the viewpoints of taxonomists and plant pathologists on classification below the genus level, I made a very brief review of a few of the many papers and books available on the subject. I was surprised to find agreement amongst modern taxonomists on the solutions to basic problems, and only minor divergence in minor concepts such as definitions and use of some infra-specific taxa. Briefly, these viewpoints are:

"Classification is the ordering of organisms into groups on the basis of their relationships by descent, or similarity, or both. Thus, there are two schools of taxonomists: those who use reasoning about phylogenetic origins in the classification, and those who use only evidence from comparative study. The recognition of natural groups as entities sharing the largest number of (weighted*) properties is an extremely important concept: It frees us from the other interpretation of natural groups as representing lines of common descent" (8).

"...phylogenies are speculative, and we are therefore establishing a taxonomy on grounds which are largely hypothetical. Empirical taxonomists do not hold that it is the function of taxonomy to investigate the mechanism of evolution" (8).

Views on the purpose of taxonomy have evolved rapidly during the past decades, "... the process of classification being removed from speculations regarding the origin of the taxa being classified" (8).

For the purpose of classification, most modern taxonomists no longer adhere to the concept that only organisms which mate and produce fertile offspring should belong to the same species ("Man nennt Species ... was sich fruchtbar miteinander gatted, fortpflanzt" (9)); nor do they define species as "... the largest and most inclusive ... reproductive community of sexual and cross-fertilizing individuals which share a common gene pool" (1).

The species concept formulated by the American Phytopathological Society in 1925 is gaining more and more acceptance: a species is " ... a group of individuals which can be segregated on the basis of morphologic characters of such a nature as to be applicable and determinable by mycologists and pathologists in general, and such as will be available for general, practical taxonomic purposes" (3). Thus, any species must be clearly separable from other species by morphological discontinuities. The taxonomic rank "variety" is reserved for minor morphological differences (which too often are difficult to recognize!).

Fisher and Shaw (2), in revising the classification of the smuts, state "It has gradually come to be recognized that the criteria which are valid in delimiting species vary in different groups of organisms." In the smuts, following Savile's (7) suggestion, they "believe that species should be delimited primarily on a sound morphological basis but utilizing, at the same time, host selection at the Host-family level." In heteroecious rusts the modern trend is towards rejection of species based on differences in only the aecial hosts.

About poplar rusts, Jorstad states: "To *Melampsora populnea* (Pers.) Karst. belong various races, usually considered as species,

*Inserted by the author and not part of quotation.

which do not differ essentially in morphological characters, but which posses different aecial hosts" (4). Formae speciales (Jorstad's) "races") are recommended for morphologically similar parasitic fungi which differ "by their adaptation to different hosts" (5).

I believe that the dearth of guidance by the Internation Code of Botanical Nomenclature (5) on how to define and use the various taxa, particularly species and infra-specific taxa, is tacitly deplored by the majority of taxonomists. In view of the urgent need for international agreement on taxon concepts, and according to the opinions expressed by most modern taxonomists, the following tentative recommendations are made for the purpose of standardizing and simplifying the classification of the plant rusts (Uredinales):

Only the following three infra-specific taxa are recommended for use: varietas (var.), forma specialis (f. sp.) and subforma (s.f.). Following are the definitions suggested:

A species is erected on differences in (a) telial and/or uredinial morphology (constant presence or absence of the uredinial spore state or spore forms like mesospores or amphispores are considered to be applicable criteria and/or (b) telial host range at the host-family level (not applicable as a criterion if host ranges overlap).

A varietas is erected on differences in (a) pycnial and/or aecial morphology (constant presence or absence of the pycnial spore state is considered to be an applicable morphological criterian) and/or (b) aecial host range at the host-family level (applicable to heteroecious rusts only; not applicable as criterion if host ranges overlap).

A forma specialis is erected on differences in: (a) telial and/or aecial host range at the host-species level (not applicable as criterion if host ranges overlap), and/or (b) telial and/or aecial symptomology (clearly delimited and observable host symptoms, e.g., globoid or fusiform swellings, presence or absence of witches' brooms, distinct and constant hypertrophies or atrophies, infection limited to cones or other fruit, stems, foliage, etc.).

A subforma is erected on differences in all other clearly delimited criteria of fungus and/or host, except: differences which are difficult to determine by the practising mycologist or plant pathologist, and minor host symptoms and degrees of host susceptibility.

The criteria excepted from subforma are to be expressed as subdivisions of a subforma (physiologic race, strain, variant, etc.,) and thus do not receive formal taxonomic recognition.

It is to be noted that in all sub-generic taxa used for rusts, only distinctly delimited criteria of morphology, host range, and symptomology are used, and that the subdivision *varietas* does not apply to rusts the pycnial and aecial states of which are absent or unknown. Form genera (*Peridermium*, *Caeoma*, etc.) are considered as Fungi Imperfecti for purpose of classification.

The audience is invited to name actual or hypothetical examples of rusts in order to test the advantages and disadvantages of the taxon concepts here proposed. For instance:

Cronartium occidentalis Hedgc., Bethel & Hunt would become a *forma specialis* of *C. ribicola* J.C. Fischer because it differs clearly from the latter by aecial host range on the species level only.

The white stalactiform rust would be named *Cronartium coleosporioides* (D. & H.) Arth. f. sp. "*stalactiforme*" new author *subforma* "*album*" new author, which can be written *C. coleosporioides* s.f. "*album*" new author without ambiguity, if the Rules and Recommendations are followed. F. sp. "*stalactiforme*" if *distinct* morphological characters of the pycnial and/or aecial states distinguish it from *Cronartium coleosporioides* var. "*filamentosum*".

Melampsora albertensis Arth. would simply become a synonym of *M. medusae* Thuem., *if* the two do not differ clearly in morphology, host range, or symptomology, *M. medusae* having priority.

Probably most or all North American willow rusts would be included under one species, *M. epitea* Thuem. with existing species to be relegated to vars. or f. spp., the choice depending mainly on differences in aecial morphology and aecial host range. Thus, *M. ribesii-purpureae* Kleb. may become *M. epitea* var. *ribesii-purpureae* (Kleb.) new author; and *M. abieti-capraearum* Tub. may become *M. epitea* f. sp. *abieti-capraearum* (Tub.) new author.

The details of the system outlined are tentative and subject to revision. Already, I am very much inclined towards further steps of simplification, such as to include the two varietal criteria (morphology and host range in the aecial state) as additional criteria for the species level, thus abolishing the use of "variety" as a taxon in the rust fungi.

The sole purpose of the proposed system is to avoid unnecessary confusion in rust nomenclature by standardization and simplification. Standardization is attained by international agreement on the meaning of infra-generic taxa; simplification is attained by reduction in the number of infra-specific taxa used for rusts and by reduction in the number of criteria used for each taxon.

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FOMES ANNOSUS IN CALIFORNIA

by

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The presence of Fomes annosus in California has been on record since the early 1900's, when it was reported from a number of areas in association with decaying stumps and heart rots of living trees (7). Since 1934, when Olson (6) reported the association of what was later shown to be F. annosus with dead and dying pines and demonstrated its pathogenicity to Jeffrey and ponderosa pines, there has been a slow but steady increase in the number of reports of F. annosus associated with tree mortality. Some of these have reported only slight damage involving the loss of one to a few trees, but others have reported rather substantial losses involving the death of several hundred trees over rather large areas (2,7).

The title of this panel "Fomes annosus, a potential threat to western forest?" ends in a question mark and rightly so, for at least in California we are not yet in a position where we can estimate the present status of F. annosus let alone its future. But, of course, there are indications. On the one hand the experience of those in Europe and eastern United States shows that the intensity of this disease increases with increased forest management manipulation. In California the facts, that the greatest losses have been associated with stumps left from recent thinnings and harvest cuttings, and that these losses usually involve the seedlings and saplings surrounding these stumps for 5 to 10 years after cutting, indicate that here too increased forest management and utilization is resulting in an increased incidence of this disease.

It is probable that the intensity of F. annosus in California is greater than our present reports would indicate, for in the West there are some major problems involved in the detection of this pest. In many other areas of the world the presence of sporophores is the main method by which F. annosus is detected in the field. In California, because of the paucity of sporophores and their hidden nature, detection by this means is not practical and the more difficult method of using host symptoms complemented by laboratory culture has proven to be the only reliable means of identification. The general problem of detection is further aggravated by the bark beetle problem of the western forests. In the latter stages of this root disease the infected tree is often invaded by bark beetles, and it appears superficially as if the tree was killed by bark beetles alone (7). Furthermore, because of this insect problem and the risk cutting system adopted as a result of it, infected trees showing signs of decline are harvested without due regard for the cause of the decline. Thus many trees infected with F. annosus are not reported or are reported as beetle kills.

This pathogen is widely distributed over the state. It has been reported from most of the national forests and has been found in both the Sierra Nevada mountains and the Coast Range mountains. Its wide distribution in the state would put it in a position to become a very serious statewide problem.

This pest is capable of causing extensive damage under California conditions. Wagener and Cave (7) reported severe infestations with rather large losses in Mount Laguna (San Diego Co.) and Hat Creek drainage (Shasta Co.). In recent years large losses have occurred at the Institute of Forest Genetics in Placerville, where 24 different species of pine, 3 pine varieties, and 1 pine hybrid were attacked and killed by F. annosus (1). At the Boggs Mountain State Forest this year a roadside survey of approximately five sections revealed the presence of some 60-odd F. annosus infection centers, containing over 700 dead seedlings and saplings (2).

On the other hand, although there are numerous reports of this pest, on a statewide basis they are far from overwhelming. Furthermore, the number of reports of F. annosus causing extensive damage in the state number less than 10. Also the secondary spread and pathogenic activity of this fungus appear to fluctuate in intensity from year to year. The infection centers in Hat Creek drainage when first observed by Wagener in 1941 were very active, each center containing numerous newly killed trees. But when these same centers were observed in 1962 they appeared to be relatively inactive and contained few recently killed trees. Some of these centers appeared to be completely dormant with no signs of any mortality having occurred within the last 10 years.

In California, the root disease caused by F. annosus appears to be typical of the disease as reported from other areas, such as southeastern United States, with the possible following exceptions.

There is a very noticeable lack of sporophores of F. annosus in California. Wagener and Cave (7) found that they were rarely produced on pines and then only on small trees. Observations to date, indicate that sporophores are found with any frequency only during the occasional year, such as this year, when frequent spring rains extend on into July, They also appear to be more numerous in some areas of the coast range mountains which have a high annual rainfall and a mild winter. Even at times and in places where sporophores are found with some frequency, they are small and usually hidden beneath a thick carpet or duff or even buried down under mineral soil. They have been found a foot or more down in the mineral soil where they were formed in the channels left by the decaying roots of an old infected stump. At times, they also occur on stumps beneath the bark on the xylem, where moisture conditions remain favorable for longer periods of time.

The symptomatology and disease development in California appear to differ somewhat from that reported to occur in southeastern United States and much of Europe, where F. annosus causes a butt and root decay before the tree dies or is blown over by the wind. In California, on both native and exotic species of pine, F. annosus invades and kills the cambium rapidly, the tree dies, and then a very slow decay of the roots and butt occurs. On the other hand, in the true firs in California, F. annosus appears to seldom attack and kill the cambial tissues of the root crown as it does in pine, but rather causes a chronic butt decay condition, which the firs seem able to tolerate for years (7).

Thirdly, the intensity of damage in any one infection center appears to fluctuate over a period of years. This fluctuation in intensity appears to be correlated with available moisture, increasing after a wet year or two and decreasing after a series of dry years.

Although these differences may appear to be minor, they do lead to some questions of major importance. How does a fungus, whose major agent of dispersal is reported to be the basidiospore, spread if sporophores are produced so infrequently and in such a poor position for spore liberation? Is aerial spread limited to the occasional year when sporophores are produced in greater numbers? What role, if any, does the conidial stage play in the establishment of new infection centers? Is it possible that insect transmission is involved? This possibility was suggested in 1946 by Wagener and Cave (7) but as yet no vector relationships have been established. The differences in disease development on the same hosts in different areas and on different hosts in the same area presents some interesting questions of host-parasite relationships and the influence of environment of the relationships. The extremely slow decay of the roots of infected trees and stumps may well extend the survival period of this pest in the soil over that reported from Europe. The fluctuations in intensity of infection in relation to the effect of environment on the host, pathogen, and their interactions need further investigation. Does excess soil moisture or oxygen deficiencies influence the severity of the disease? And, if so, is its influence mediated through the host, the pathogen, or both?

In California, as in the rest of North America and most of Europe, a large portion of our research is concerned with the establishment of new infection centers. More recently the group has become involved to a somewhat greater degree in a laboratory study of the fungus itself. The main interest is concerned with the natural variation existent in the species and the genetic controls of this variation. Etheridge (5) reported the existence of variations in growth rate (8.6 mm./7 days to 67.9(mm./7 days., colony appearance and rate of sporulation between 16 isolates of F. annosus from North America and Europe. He also noted that new variants frequently arose during subculturing. Braun (4) reported that similar variations existed in his European isolates, noting particularly variations in growth rate, mycelial appearance, and color.

Presumably Etheridge and Braun reported the existence of variations among a number of dikaryons. The characteristics expressed by such a dikaryon are the result of an interaction between the two monokaryotic components. Recently Bega and Hendrix (3) reported on the existence of similar variations in monobasidiospore cultures isolated from a single sporophore. Variations were noted in growth rate, colony type, colony margin, and the degree of asexual sporulation. The growth rates ranged from 2 mm. to 41 mm. in 7 days. The colony margin when divided into two categories, smooth or fimbriate, showed a 1:1 ratio as did asexual sporulation when rated as heavy or light.

Genetic studies are dependent on the ability to produce the perfect stage in pure culture in a convenient manner with some regularity. This problem of the in culture production of sporophores is now under investigation by Dr. R.V. Bega. So far he has been able to obtain the perfect stage in test tube culture only with naturally occurring dikaryons. All attempts so far, at producing the perfect stage by mating monokaryons obtained by single basidiospore isolation have been negative. When such matings are possible one will then be able to proceed to the questions of compatibility, dominance of characters in heterokaryons, nuclear life cycles, etc. With such information as it is hoped these studies will yield, one may then undertake the study of variations in pathogenicity and their genetic control.

In summary, the root disease caused by Fomes annosus is being recorded with increasing frequency in California. Although it has been of relatively little importance in the past, there are indications that it may well become one of the most important disease problems in the state.

Observations have indicated that the following are some of the most important areas in need of research; aerial spread (including inoculum, inoculum production, dissemination, and inoculation), pathogenicity (including host-parasite relationships and environmental effects on virulence), and the pathogen (including its physiology and genetics).

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Investigations on the Occurrence and Control of *Fomes Annosus* Root-Rot in Slash Pine Plantations of the Gulf Coast

Chas. H. Driver*

Annosus root-rot is fast becoming recognized as a most serious factor to be concerned with in the practice of intensive forestry in the southern states. Pine plantation management is the most intensive form of forestry that is practiced in this country today. The promise of high returns on the invested dollar and the short period of time required for a relatively high volume yield of wood per acre merchantable for the production of pulp and paper products are the reasons for this intensive management in the southern states. Slash and loblolly pine are the two major species cultured under these intensive conditions.

It is commonplace for a plantation on average or better sites to be thinned at least once by age of 15 years. An example of the extreme of this is a case that by the age of 15 years and old-field slash pine plantation was being prepared for the second merchantable thinning. In this case annosus root-rot had become established throughout the stand following the first thinning that had occurred five years previously (1). A portion of this stand was clear-cut as a part of an experiment to study the effects of an annosus root-rot infested site on regeneration by planting and direct seeding. In this case approximately 35 merchantable cords of wood per acre were harvested from this stand at the end of a 15 year growth period.

Such conditions as this have induced the wood based industry of the south to become intensely interested in forest pest detection and control. As a result, close cooperation is being fostered between universities, federal and state forestry organizations and industry. Forest disease and insect research is being supported very actively by these groups. As a result of the cooperation, survey and research data on the occurrence of annosus root-rot in southern pine plantations can be characterized in the following manner (1,2 &5).

1. The first recognizable symptoms of the disease to a practicing forester appear two to three years after the first thinning operation. These are:

(a) Yellowing of the crown during dry periods of the year.

(b) Thinning of the foliage of the crown proceeding from the base up.

(c) Wind-throw of apparently healthy trees. Inspection of the root system shows that obvious deterioration of a major portion of the lateral root system and the tap root is apparent.

(d) Infection centers can be detected in the stands by the occurrence of dead standing trees. Usually one to four tree groups are typical of these first detectable infection centers.

2. At this stage of our knowledge there appears to be no difference in the resistance to the disease between the slash and loblolly species. Plantations of both species have been observed to exhibit extensive mortality following thinning operations. Loblolly, however, has been observed to exhibit heavy mortality on two occasions in "unthinned" plantations.

3. Mortality tends to increase as years since thinning increase. It also increases with more frequent thinnings.

4. Plantations occurring on former cropland (old-fields) exhibit higher mortality than those on land continually forested (wild-lands). Sites with lighter soils (sandy) have more damage than those with heavier soils.

These site conditions are both common in the pine plantations of the coastal plain of the southern states.

5. The extent of mortality can vary from stand to stand. It is becoming apparent that much of this irregularity can be due to the effect of enviroment on the ability of F. annosus to successfully colonize freshly cut pine stumps.

An example of extreme mortality was observed that amounted to approximately 36% of the remaining merchantable timber being dead or dying in a six year period following the first thinning of an actively growing plantation.

Such mortality rates as this emphasize the threat that annosus root-rot imposes on the economy of intensive forest management in the deep south.

The subject of mortality naturally brings to mind - "what can be done to prevent it?" After four years of intensive investigation on the occurrence and control of annosus root-rot practical control measures are beginning to be defined (3 & 4).

Two approaches are being made on the control of annosus root-rot in pine plantations in the Gulf Coastal Plain.

1. The direct control approach consists of preventing the establishment of the disease following initial thinning operations. Presently, this approach is being accomplished by treating the surface of pine stumps with Borax immediately following tree felling.

The data in Table 1, which are the results of a series of trials, demonstrate several interesting relationships.

(a). Borax (sodium tetraborate) gives good control of stump surface infection by F. annosus when applied either as a 10% (w/v) aqueous suspension or in the dry form.

(b) This compound was found to be significantly more effective than creosote or pentachlorophenate for the control of F. annosus.

(c) Borax gave protection for at least 7½ months. Ecological studies on pine stump fungal colonization showed there was little chance of F. annosus successfully infecting stumps after this period under the conditions tested. In addition, the time of inoculation trials data demonstrates that pine stumps in this test area had a relatively short period of susceptability to become infected by F. annosus.

2. In addition to this direct control method it appears that it may be feasible to apply a system of "natural control". Observations on the apparent effects of environmental factors on the ability

of F. annosus to successfully colonize fresh pine stumps indicate interesting possibilities.

It was observed that when a portion of a plantation was cut in the winter, many infection centers of annosus root-rot occurred. However, when a portion of the same stand was cut during the summer a low rate of infection was evident. Going on this lead, an experiment was designed to test these observations. A portion of a similar slash pine plantation was scheduled to be cut during a period of high temperature (July and August, 1959) and a second portion of this same stand was scheduled to be cut during a period of relatively low temperature (January and February, 1960). It is believed that temperature does not necessarily select against the ability of F. annosus to grow but it selects for the ability of competing organisms to more successfully colonize the fresh pine stumps under the existing conditions.

Thusly, when operationally feasible, silvicultural thinning operations conducted during periods of hot and preferably dry weather may provide for the natural control of annosus root-rot in slash pine plantations in the Gulf Coastal Plain.

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TABLE I

EFFECT OF CHEMICAL TREATMENTS ON SLASH PINE STUMP SURFACE INFECTION BY *FOMES ANNOSUS*

TIME	10% W/V BORAX			10% W/V BORATEEM			CREOSOTE			0.6% W/V P.C. phenate			INOC CONTROL			UNINOC CONTROL			MONTH CUT
TREAT-SAMPLING WKS	NO. OF STUMPS		% INFECTION	NO. OF STUMPS		% INFECTION	NO. OF STUMPS		% INFECTION	NO. OF STUMPS		% INFECTION	NO. OF STUMPS		% INFECTION	NO OF STUMPS		% INFECTION	
	SAMPLED	INFECTED		SAMPLED	INFECTED		SAMPLED	INFECTED		SAMPLED	INFECTED		SAMPLED	INFECTED		SAMPLED	INFECTED		
12	8	0	0	9	1	11	15	7	47	16	11	69	15	13	87	6	2	33	
30	10	0	0	10	0	0	10	7	70	-	-	-	15	14	93	10	1	10	NOVEMBER
				5% W/V BORATEEM						1.2% W/V P.C. PHENATE									
9	6	0	0	6	0	0	6	1	17	6	1	17	6	5	83	4	0	0	
13-14	10	0	0	10	0	0	10	2	20	10	1	10	12	3	25	10	0	0	
24	10	0	0	10	0	0	-	-	-	-	-	-	20	0	0	10	0	0	JANUARY
				DRY BORAX			7.7% W/V RASORITE			DRY RASORITE									
12 inoc 1hr.	10	0	0	10	0	0	10	0	0	10	0	0	10	7	70	15	1	7	
12 inoc 24 hrs	10	0	0	10	0	0	10	0	0	10	0	0	10	1	10				MARCH
12 inoc 14 days	10	0	0	10	0	0	-	-	-	-	-	-	10	2	20				

P.C. phenate = pentachlorophenate

THE ROOT PARASITE *FOMES ANNOSUS* IN FOREST TREES OF THE INTERMOUNTAIN AREAS

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Fomes annosus occurs commonly as a root parasite throughout the timbered areas of Idaho, Utah, and the adjoining Intermountain country. Although no one has made a survey of its prevalence or of the damage it causes, *Fomes annosus* is known to be a serious problem in southern Idaho ponderosa pine stands following partial-cut timber harvesting. The parasite causes death of trees of all ages from seedlings to mature veterans.

This fungus also occurs as a root pathogen or causes heart rot in other Intermountain conifers including western white pine, western hemlock, and the true firs. In most affected tree species, decay caused by this fungus is confined chiefly to the trees' roots and butts; however, typical heart rot may occur in the lower bole in true firs and hemlocks.

Sporophore production is rare on large trees and occurs only occasionally, under particularly favorable moisture conditions, on saplings. When sporophores are produced, they are on the root crowns or primary roots several inches below the groundline on trees recently killed by the fungus.

Mode of Action:

The importance of infection by basidiospores is unknown, but in local spread, tree infection by root contact or proximity to other infected roots is common. Infection may occur anywhere on a tree's root system, either through a wound or directly into an unwounded root. The fungus spreads on the infected root to the root crown, and then progresses around the root crown and out into other primary roots.

On ponderosa pine, and to some lesser extent on other species, the roots are killed one by one, and subsequently decay. This progressive deterioration of the functional root system causes a reduced rate of tree growth. Reduction in width of annual growth rings first becomes evident on larger trees when the root crown has been about one-fourth girdled. The tree is not killed by the fungus until girdling is complete, but by this time growth has practically ceased. Occassionally a tree is windthrown before it is killed, because of decay in the anchoring roots; but more often, bark beetles, particularly the turpentine beetles (Dendroctonus valens), attack the weakened trees and kill them before girdling is complete.

After a tree dies, the F. annosus fungus spreads rapidily throughout the root system and thereby provides an abundant source of inoculum for associated root systems of neighboring trees. Other trees become infected and are killed, and their root systems in turn produce more inoculum. Eventually groups of dead and weakened trees form recognizable "annosus"centers in a stand. Thrifty vigorous trees can combat root invasion and retard progress of the organism in the infected roots by heavy production of resin in the infected parts. However, when such a tree is cut in logging, the fungus that has been held in check by resinosis will develop rapidly throughout the root system of the stump just as it does in the root system of a tree that it kills. This causes the buildup of the fungus, with resulting heavy damage in residual stands after partial cutting.

Symptoms and Signs on Infected Trees:

Around a killed tree or a stump, first a few seedlings or saplings and later older trees begin to show symptoms of infection.

Young trees.-- On seedlings and saplings the first indications of F. annosus infection appear in the new terminal and lateral growth. The new growth is shorter than that of previous years; also, the new needles do not attain normal length. Later, the foliage becomes yellowish green and then yellow, and reddish brown after death. The killing is slower than that by Armillaria mellea, which usually kills small trees quickly before their growth is retarded. Thus, F. annosus centers usually can be distinguished readily from the similar centers caused by the shoestring fungus.

A definite diagnosis of F. annosus may be made in the field by examining the cambial region at the groundline on dying or recently killed seedlings or saplings. Under the dead bark at the groundline, fine tan and reddish-brown striations appear on the wood surface and under surface of the dead bark. Definite fans of white mycelium are never found in F. annosus-killed trees, as they are on trees killed by A. Mellea.

Older trees.-- On larger (pole size and mature) trees, the first symptom is a thin appearance of the foliage accompanied by twigs' dying throughout the crown. An accompanying sign of infection may be seen on an increment core taken from the tree bole. The growth rings become successively narrower, and in 3 to 8 years after the first retarded increment the rings often cannot be distinguished without a hand lens. On large mature trees the first killing in the cambium apparently occurs in the bark crevices, producing isolated dead patches under the bark plates. The tree usually dies in the year following the patch-killing of the cambium. When bark is removed from such dead trees, evidence of the original patch-killing is clearly seen. Years later, old dead trees or snags may be recognized as having been killed by F. annosus by this characteristic sign.

SUMMARY FOR FOMES ANNOSUS PANEL

G. Wallis

In conclusion, it would seem to be in order to emphasize a few of the problems still facing us in the spread of and control of Fomes annosus as brought out in the papers and in recent literature.

Spread:

It is probably generally conceded that spores are capable of spreading the root rot by the infection of fresh wood surfaces; but little is known about other possible means of dissemination: do insects and rodents play a part? what of the role of conidia in nature? what are the possibilities of infection from spores which have been washed down into the soil? what part does infection of scars play in the dissemination of the disease?

Is it possible, as has been suggested on a number of occasions, that the fungus may spread from tree to tree through the duff and soil horizons?

We know that Fomes mycelium may spread from a diseased to a healthy root where they are in contact. What however, is the effect of the environment on the rate of spread? Do the chemical, physical and microbiological properties of the soil have a direct relation to rate of spread? It has been shown that losses are greatest on land formerly used for agriculture, in planted versus natural stands, and in light versus heavy soils. How are these factors operating -- directly on the fungus or as agents weakening the host to Fomes attack? In certain regions heavy pine mortality has been associated with high soil pH, while in other regions extensive butt rot of other species is found on soils with a low reaction. What, then, is the nature of soil reaction as a factor affecting disease intensity?

Control:

Every effort should be made to exclude the fungus from stands as yet free of the disease. The cost of preventing infection of stumps or scars by spores will be significantly less than any methods that may be used to try to control F. annosus once it has become established.

A great deal more study is required on the disease in stands where the root rot is well established. A better method of detecting the early infection state of the disease would be an asset. If we are not going to treat all areas we must have some means of designating high risk areas. Resistant species may eventually be used to reduce losses; artificial inoculations may be used to shorten the time required to test likely species, while a study of root morphology may aid in choosing likely candidates. Chemicals have not as yet been investigated fully in the control of root rot. It may be possible to use soil drenches around infection foci to kill roots and isolate the disease from the remainder of the stand. Although it may not be possible to destroy the mycelia in trees already infected, the feasibility of inducing resistance in healthy trees with systemic fungicides to prevent spread needs to be investigated. Possibly it will be necessary to establish resistance with chemicals in seedlings in nurseries, and then - by periodic spraying - carry trees through to commercial maturity.

These are but a few of the many problems which need considerable attention if we are going to become completely familiar with Fomes annosus and effect a realistic control.

FOREST PATHOLOGY IN RETROSPECT:

CHANGING SUBJECTS, CONCEPTS, AND ATTITUDES.

WITH A CRITIQUE OF PRESENT TRENDS

Willis W. Wagener.

In assigning the topic of this contribution to the panel I feel that the program committee may have overestimated my insight and powers as a seer and prophet. Therefore, I hope that you will not expect too much from me in the way of sage analysis in what follows, especially with respect to present and future trends.

As a foundation to enable you to make your own comparisons of the present with the past in western forest pathology - and I will interject that my remarks will be confined almost entirely to forest disease activities in the West and not to those in North America as a whole - I will first try to sketch forest pathology as it was west of the Great Plains in 1917, the year in which I had my first contact with it as summer Field Assistant in Forest Pathology with the San Fbancisco Branch of the Forest Pathology Division.

Then:

Organization, function, and location. Administratively Forest Pathology was at that time a Division in the Bureau of Plant Industry, U.S. Department of Agriculture and there were three branches in the West: one at Albuquerque, New Mexico, attached to the District Office of District 3 of the U.S. Forest Service; one at San Francisco, California attached to the District 5 office of the Service, and one at Missoula, Montana attached to the District 1 office. It was not until some years later that the District designation was changed to Region and the District Foresters became Regional Foresters. By an agreement first signed in 1907 and amplified in 1910 between the Chief Forester of the Forest Service and the Chief of the Bureau of Plant Industry the pathologist in charge of each field branch of the Division attached to a District Office of the Forest Service became Consulting Pathologist to the Service for that District and such others as might be assigned to him. The District where he was headquartered supplied quarters and clerical assistance to the Consulting Pathologist. Thus, although the primary function of the Division of Forest Pathology in the Bureau of Plant Industry was research on forest tree diseases, the function of the men in charge of the western branches was a dual one, that of supplying consultative service on tree diseases to the assigned Forest Service Districts and also of the investigation of such diseases. The assignments included not only diseases of foresttrees in the assigned territory but those of shade and ornamental trees as well. It was a big field in a big territory.

At that time there was no comparable activity in Canada, either east or west. It was not until 1920 that W.H. McCallum was appointed as the first forest pathologist in Canada and began field work in Quebec. Likewise there was no one on university staffs, either in Canada or the United States, teaching exclusively forest pathology.

Personnel:

In the United States those at the western Branches in 1917 consisted of W.H. Long at Albuquerque, with one woman laboratory assistant, E.P. Meinecke at San Francisco, with J.S. Boyce as Assistant and from two to three summer field assistants, and J.R. Weir at Missoula with one full-time assistant and occasional summer assistants. Of the several persons filling the full-time position between 1913 and 1920, E.E. Hubert had been one.

Programs:

At all three western Branches a primary activity after establishment had been field surveys to find out what disease organisms were present in their territories as far as limited budgets permitted. At the San Francisco Branch much of this survey work was conducted on horseback, as at that time there were many more trails than roads through the forests. Instead of Government cars as we now have them, the Branch possessed a Government saddle horse and saddle. This means of locomotion had certain limitations with respect to spead of coverage but it allowed the rider time to really observe the forest as he passed through except for those infrequent times when ground-nesting yellow-jackets had chosen their homes in the trail. In that case rapid action sometimes resulted.

At San Francisco this survey work provided most of the basis for the first field manual on forest diseases to appear in the United States, E.P. Meinecke's "Some Forest tree diseases common in California and Nevada" issued in 1914. Another principal activity at San Francisco was an investigation of cull from rot in virgin forest stands. This was begun in white fir in 1911, first near Klamath Lake in south central Oregon and later in various locations in California. It was also extended to incense-cedar, first by Meinecke and then by J.S. Boyce.

Another type of study, conducted on logging operations, dealt with cull in trees and snags of merchantable size and furnished the basis for the adoption of the so-called "sanitation clause" in Government timber sale contracts. This provision required operators in timber cut on national forests to fell unmerchantable trees and snags on the sale area. The objective was not only sanitation of the forest but silvicultural and fire hazard reduction benefits as well. The tree rusts were being given attention and Meinecke was working toward proof of the direct aecial infection from pine to pine of Peridermium harknessii. White pine blister rust, which later gained so much attention by forest pathologists in the West, was well established in British Columbia by 1917 but that fact was not known at the time and the only activity then on the rust in the West was the field checking by two temporary summer employees of white pine planting that may have resulted from imports of white pines from abroad. The first phase of this was a check through untold thousands of musty and dusty import records in custom house attics to learn who had imported white pines. From the records found it was the field man's job to find out what plantings resulted and whether or not these showed white pine blister rust. No rust was found in any such plantings in the western United States.

Weir's branch in District 1 was a beehive of activity from which numerous manuscripts flowed, perhaps a fourth of which were not cleared for publication. They covered a great variety of subjects including tree rusts, heart rots, dwarfmistletoes, root diseases, and needle diseases. He was the first to describe the disease from Elytroderma deformans, then called Hypoderma deformans, and the first to try the artificial planting of dwarfmistletoe seeds on twigs.

At Albuquerque, Long's investigative program was somewhat more restricted than at the other two western Branches and was concerned chiefly with decays, rusts, and with dwarfmistletoe of ponderosa pines.

Program control at the western Branches was informal, limited, and mostly verbal unless the Branch head wanted more money than he had been allotted and sought to sell his proposed studies to the Division Chief in Washington through correspondence. There was no such a thing as a formal study plan to be approved in advance and plans were usually worked out on the ground as the study progressed. Personal contacts between heads of Branches were extremely limited. Under these conditions the Branch heads tended to be individualists, accompanied by a certain amount of provincialism if the individual tended to be inclined that way.

Freedom from close control other than through allotments had good and bad aspects, depending on the individual. For the creative man with a solid background and good judgment it permitted a maximum of accomplishment with a minimum of administrative chores and distractions; for the less endowed or less energetic individual it gave an opportunity to get by without signal accomplishments. Fortunately, at the time of which I am speaking, none of the western Branch heads fell in the latter category.

Laboratory facilities:

In general, these were rather minimal. I cannot speak for the other Branches at the time but at San Francisco we had one top quality monocular compound microscope, several cheaper but good quality ones, a good sliding microtome, a fair ether-freezing microtome (CO_2 in cylinders was not then generally available) a limited supply of glassware and an Arnold steam sterilizer. For those not familiar with this venerable piece of apparatus it may be described as a steam generator surmounted by a hood to contain the steam. Articles or media to be sterilized were subjected to live steam for three successive days. The Arnold was produced in a double-walled rectangular form with doors but we had the cheaper cylindrical form with lift-off hood at San Francisco.

Field Work:

For an impression of field work at the time I might briefly describe my first assignment. We were to work on what was designated as a dissection study in unlogged virgin white fir on the west slope of the Sierra Nevada at about 5,500 feet elevation. The object was to find out what defects were present that were of pathologic origin and how they were related to age, wounding, and other possible influencing factors.

The first job at headquarters was to get the field equipment ready for shipment, including tents, cooking outfit, saws, axes, peavies, sledges, wedges, gluts, pocket tapes, hand lenses, and a genuine old-time surveyor's chain of 100 wire links and two generous-sized, swivelled pulling handles. All were shipped by rail and we followed, first by train and then by heavily overloaded Model T stage to the small mountain town that was then the Supervisor's headquarters of the Sierra National Forest. At selected locations as the road climbed through the foothills the driver would stop the Ford, unscrew the radiator cap, and duck. A geyser of steam and hot water would erupt, after which the radiator would be refilled and we would be on our way.

The balance of the trip a day later was by two-horse wagon, with equipment, luggage, an estimated two months' supply of food staples, lumber for tent floors, and ourselves plus driver. By the time the horses had pulled this load up a rise of 2,500 feet in 8 miles to reach the work area they had earned their oats.

The crew consisted of three field assistants, two local woodsmen, and a lady cook in her 50's who was the wife of one of the woodsmen. She was thoroughly at home at mountain cooking for a small crew and we ate well. The equipment did not include cots so we made fir bough beds. A correctly constructed fir bough bed can be very comfortable but it needs renewing from time to time to stay that way. The supply of boughs close to camp soon became scarce and renewals were postponed. Fortunately, we got harder along with the beds and were eventually sleeping on a layer of dry limbs.

The camp was located among towering sugar pines on a side road which dead-ended at our meadow and we had no means of transportation. The only way to go anywhere was on foot and there was no great compulsion to go down to the hot foothills by that means so we did not go. Under these circumstances there was little need to spend money so the $60. monthly salary check was almost all velvet until the field season ended and it was time to return to headquarters in San Francisco.

In camp we ate outside, which was fine until along in August, when the yellow-jacket population became so thick that it was necessary to eat with one hand while fanning the food with a piece of shake with the other. A yellow-jacket sting on the tongue can be dangerous.

In the field we were not bothered by statistically controlled sampling methods. The opinions of experienced forest officers had previously been obtained on the representativeness of unevenaged mixed virgin stand. We simply went out and started felling white firs in a meander pattern. Felling was extended to as many differences in terrain and surroundings as were available within convenient walking distance. As the season progressed a tally was made of age classes of the study trees and if the basis for a specific age class was weak, preference in felling was given to trees that appeared to be of that age class. In the end we probably obtained as good a sampling by age classes as the area afforded.

Hours in the field were not too different than now except that we worked on Saturday and foot travel to the job and return was not on Government time. On the job everyone kept busy, whether the work was in his major assignment of duties or not. Thus, if a Field Assistant was not busy taking measurements or counting ages of trees or wounds he might pile slash or split logs. Frequently all hands were summoned to heave on the peavies if a large log had to be rolled or the split halves separated. The checking of field notes for omissions or discrepancies was an evening or Sunday job, as well as any needed trips to the woods for corrections. In general, emphasis was on getting the job done right, not on the number of hours required for the doing.

Then Versus now:

So much for our glimpse into the past. How does it compare with present-day forest pathology in the West?

Obviously official life was much simpler administratively then than now. The old Bureau of Plant Industry was a highly decentralized organization, with most of its staff stationed in the field and working on such diverse crops as grains, cotton, lettuce, and dates. But even an organization such as the U.S. Forest Service had little in the way of administrative directives then as compared with now. Compare the 5/16-inch thickness of the 1915 Forest Service Use Book with the approximately 3 feet of shelf space required for the current Forest Service Manual.

There was also a wide choice then in the selection of problems. The forest disease field in the West was still practically a virgin one and only a very little of the cream had been skimmed off. Almost everything one turned to was new and, with only a few, widely separated workers in the field there was little competition on an individual problem. In those days oak wilt had not been discovered.

Accomplishments per man were greater because there were not the distractions from concentration on investigative effort that exist now. Publications on forest dieases were few and easily encompassed, especially after those from Germany were cut off by the outbreak of the European war, later to become World War I. There were no staff meetings, no in-service training programs or training films, no safety programs, no general integrating inspections, no public relations activities, and no Western International Forest Disease Work Conferences, either with or without special indoctrination on the recreational attractions of western Wyoming.

Actually, at San Francisco at least, there was training but without any formal set up or agenda. It was Meinecke's custom to go out with his men to the field at convenient times for practice in sharpening their "powers of observation," as he termed it. This included not only fungi and diseases but might cover anything in forest botany, ecology or forestry. At the office there were also occasional informal sessions, starting with almost any subject in the broad forestry or pathological field and leading on with discussion from there. If any blanks in a person's knowledge of what was discussed were uncovered the deficient ones were expected to look them up and become informed. This wholly informal type of training was something that to me was extremely valuable. However, it took a man of Meinecke's attainments, background, and personal interest in his men to make it so.

Specialization in particular lines of work, as it has later developed, was practically unknown but is now becoming almost inescapable because of the number of workers presently in our field, the rapidly expanding technical literature, and the more detailed types of investigation now needed.

The laboratory of today bears little resemblance in either equipment or cost of those of 1917, but I am not sure that all of the equipment now seen justifies itself. I get the impression that the possession of new and costly equipment has become somewhat of a status symbol, something to show off like a new sports convertible rather than a prime necessity. There is also the occasional worker who seems more interested in sophisticated apparatus for solving a problem than in the problem itself.

Of course, status is sometimes important, although there is no substitute for solid accomplishment in gaining it. I am also aware of get-it-while-you-can situations. Neither would I decry the purchase of really needed equipment. What I do not favor is the acquiring of equipment merely for the personal satisfaction of having it around and at the expense of more fruitful avenues of the use of funds. We all know of people who are riding around in Cadillacs or equal that they cannot afford.

Proof of the statistical validity of study results dealing with numbers or percentages is now taken for granted but it was not always so. Meinecke's comment that the use of statistical methods to determine validity was like "using a razor to cut butter" illustrates the attitude of the old-time pathologist toward satistical proofs. Statistical methods are now accepted as a way of life by pathologists but it is well to remember that they do not always tell everything. I recall one case in which progenies from parent trees selected for susceptibility and non-susceptibility to a rust were artificially exposed to infection in a large moist chamber. After statistical comparison of the results the geneticists reported no significant differences in susceptibility between the different lines of the progeny but one glance at the progenies side by side in the beds gave ample visual evidence that there were pronounced differences in the pathological effects of the rust on the progenies. Statistics can evaluate only the attributes specifically compared and can be only as accurate as the rating systems employed and applied.

With few workers and few professional editors, publication was easier in the old days than now. There was not the same push for brevity and not the same penchant by editors for substituting their own pet words and expressions for those of the author. Individuality in writing style, as long as it stayed within the accepted rules of grammar and sentence structure, was tolerated to a greater degree than now. Also tolerated was a reasonable amount of suggestion or speculation if it seemed well grounded, as an aid to the reader. Now it is almost invariably struck out. While present-day editors bear down on length and conciseness of longer papers it still seems possible to get inconsequential papers or notes published providing they are short. Evidently editors are more willing to require a long paper with real meat in the content to be condensed than they are to completely turn down short manuscripts even though the content may be of questionable worth.

A Look Ahead:

So much for the past versus now in the West. What of the future? At present we are in the stage of reexamining many of the old beliefs and assumptions with respect to forest tree diseases and are finding that some are erroneous and that nearly all require modification.

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Much more of this reexploration needs to be done. We have passed through the first impact of antibiotics in the control of diseases and particularly of the rusts and are gradually reaching an understanding of what may be expected from them and what was only unrequited hopes and optimism. The challenge of what to do about root diseases, both of seedlings and of older trees is still a long way from being fully resolved in many parts of the West.

With the number of investigators now in the field, however, we can expect sooner or later to reach a reasonable understanding of the really relevant disease problems affecting forestry in the West and what is practical in their amelioration and what is not. What do we do then? As I see it, there will always be a place for the well trained investigator with a lively interest and imagination in our field but what of the rest? Shall they fall back on a career of scientific boondoggling, as has happened in many other disciplines? The ambitious administrator would probably say yes. I do not feel competent to predict so will leave the answer to the future.

FOREST PATHOLOGY IN RETROSPECT

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Introduction:

Apparently our Conferences have established a continental reputation of being the most productive meetings in forest pathology in North America. Undoubtedly, this is partly due to the informal, frank, and open discussions on research, much of which has not or may never reach the point of publication. Statements have been made that the forest pathologist bares his soul , in different ways, at these meetings, and I sincerely regret not attending these sessions to provide further evidence in support of this contention.

At the outset it should be acknowledged that the numbers of forest pathologists and supporting personnel have increased greatly during the past 15 years which may be interpreted as direct evidence of the importance of our forest discipline. Pages and volumes could and possibly should be written summarizing accomplishments made to bring about the present situation. One characteristic of Human Nature would appear that although we are very familiar with our virtues, we never tire of having them repeated by others. Therefore, although we recognize our excellent progress, the possibility may exist that

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serious thought could be given to "ways and means" of improving our status. A papor on "Forest Pathology in Retrospect" would offer an opportunity to outline a few generalities that may be controversial in nature. Obviously, the information provided should be considered as another frank, soul-bearing statement outlining some opinions of the author. Furthermore, the opinions expressed are based entirely on experience in Canada.

The Organization of Forest Pathology

In the Federal Government:

Initially, it would seem necessary to refer briefly to the organization of forest pathology since organizational problems cannot be separated from work programs.

Prior to 1950 Government Headquarters considered the forest pathologist with approximately 7 years training in University and several years woods experience competent to manage a few thousand dollars annually for the purpose of undertaking the research in an area. Seasonal and continuous personnel were hired, fired, and paid locally, many of the arrangements being completed in a matter of minutes. Complete freedom was given in the purchase of necessary field equipment and supplies. The end result was that a minimum amount of time and effortwere required to handle the local administration, thus providing the maximum time for research. The system appeared to work since many of the present Officers-in-Charge of Laboratories and other senior personnel in Forest Pathology were recruited in this manner. Furthermore, the average annual production per forest pathologist in the form of publications, Industrial and Public interest and support have not been surpassed, if equalled, in later years.

In some respects it would seem unfortunate that around 1950 it was decided that the Forest Pathologist should not be required to spend his time administering matters of personnel or the purchase of equipment and supplies. Administrative personnel either was available or could be appointed at Headquarters to assist the Field Pathologist in these tasks. It is unnecessary to enlarge on the Cancerous growth of forms, directives, reports, documentation, travel, meetings, etc. that arose with the development of the new era. Indeed, the principle seemed to develop that "the productivity in pathological research varied inversely with the number of directives issued by Head Office". Without discussing the pros and cons of the new system it would seem clear that now many of the most competent and experienced researchers in forest pathology are spending considerably more time on administration than was required under the previous system.

In conversation with some forest pathologists it appeared that the types of problems under study and their manner of execution were influenced strongly by the motive to please others within the organization. This is an admirable approach provided that the work also meets with the pleasure of the Investigator, Forest Interests and the General Public. Frequently, it does not seem to be appreciated that the ultimate of pleasing rests with the field pathologist at the Laboratory Level who may be in frequent turmoil endeavouring to please not only representatives within his and other Federal Departments, but also those of Provincial and Municipal Governments, Universities, Forest Industry and the General Public. It may be true that these agencies are listed in order of priority of pleasing, and if so, how much time is left to please the Forest Industry and the General Public?

In the Universities:

The Forest Pathologists within the Universities would appear to have comparative freedom (touch wood) and full responsibility for the expenditure of research funds. It would seem significant that a number of these pathologists administer sizeable grants, participate in the administration of University Departments, prepare, revise and teach courses, direct graduate students, research associates and technicians, and still find the time to undertake research and prepare scientific publications. I would not agree that the University pathologists have greater ability than others. Is it possible that part of the answer lies in the fact that the University pathologist may not be confronted with a multitude of problems suggestive of over-organization and unwarranted emphasis on problems related to administration?

The thoughts mentioned may be summarized by reference to opinions of highly-qualified scientists that have expressed concern over recent trends in organization of research. For example, the following is quoted from a statement of the strongest convictions of the Late Dr. E.W.R. Steacie, President of the National Research Council of Canada 1952 - 1962.

> "For creative work in science complete freedom is essential. Over-organization of science and scientists is to be avoided".

Many issues of Science over the past several months contain one or more references to the magnitude of the organizational problems that are developing in research and science. One reads titles as follows:
"More Paper Work, Less Research", Science, 139, No. 3556,
"Bench vs. Desk: Dilemma for the Creative Scientist", Science, 140, No. 3571,
"Government Research Grants: Effect of the New Procedures on the Individual Investigator", Science, 140 No. 3571,

"Are we Retrogressing in Science? Despite Superficial Evidence to the Contrary, Science in the United States is in a state of Confusion", Science, 139, No. 3558.

Every Forest Pathologist should read these and other articles that have been published recently expressing serious apprehension with respect to the future of the researcher. It would seem unanimous that Government Policies should shape the research of the country. However, it is felt by many that neither the researchers nor the adminstrators have given much attention to what may be considered as a favourable environment for the prosecution and growth of research. In other words who in the Government has as his primary responsibility the duty of giving continuing, serious thought to whether organizational procedures may have been of a positive or negative nature?

Work Programs in Forest Pathology

Research Sophistication:

More recently it would appear that research on some problems has been fashioned at such a high level of sophistication that it may be impossible to achieve results of practical value to Industry within a reasonable period of time. Perhaps, greater recognition and consideration could be given to important problems of Industry in the production and utilization of timber, with a full appreciation of our present stage in development of forest management and that which may be anticipated within the near future. In addition to longer term objectives involving fundamental studies the scope of research on a problem might include short term objectives based on empirical trials (bad words) that may prove of immediate benefit to forest management. Indeed, within my experience it has been evident that Representatives of Industry have been eager to obtain results of this type of work and have been most cooperative in providing facilities, personnel, equipment, for its continuation. Furthermore, promising leads of practical value result in representations of Forest Interests to Government followed by political recognition and insistance that additional personnel and financial support be granted to the work. Indeed, a sizeable portion of the present establishment of Forest Pathology in Canada developed in this manner. Therefore, it would seem imperative that our research be conducted in a manner that would offer possibility of frequent demonstrations of the practical value of our work in order to maintain the interest and support of Forest Authorities. Otherwise, this interest may wane and forest pathology assume a static condition.

Definition of Forest Pathology and the Forest Pathologist:

A common definition for tree disease is "any abnormal disturbance to the normal functioning of a tree or stand except those caused by fire and insects". It may seem elementary but one of the most important advances made by Forest Pathologists in recent years has been recognition that it is impossible to express abnormality without knowing what is normal for a tree species under different growing conditions. This has let to the recruitment of ecologists, physiologists, biochemists, bioclimatologists, etc., to collaborate with Field Pathologists in investigations of disease problems. Indeed, most of these investigators are engaged in difficult and painstaking field work to provide results on problems as; the characteristics of root systems, vegetation and soil types, environmental influences on infection, and natural developmental studies in plantations. Unquestionably, this work is of utmost importance to the solution of disease problems. However, problems may arise when the Field Pathologist engages the services of the Laboratory Researcher.

In this era of specialization and fadism it would no longer appear necessary for some Laboratory Pathologists to have acquired sufficient training as a Forester or a Naturalist to appreciate the many interactions of the forest on the host, pathogen, and field investigator. Indeed, it would seem possible to undertake research on disease problems without leaving the Laboratory and without reference to living host material. Frequent, acceptable publications arise from this approach although many Foresters and Field Pathologists find difficulty in relating the results to the disease problem under investigation. In some instances the findings appear as well-performed laboratory exercises on an academic subject. Unfortunately, the accomplishments of the Field Pathologists may be gauged on the basis of number of publications in a manner similar to that of the Laboratory Pathologist. Too little recognition may be given to the fact that the broad range of problems encountered in field programs drains the time and energy of the Field Pathologist and provide much less opportunity for conducting research per se and the preparation of publications. Furthermore, it cannot be over-emphasised that Field Pathologists comprise the backbone of the Organization through their efforts to provide results of economic value to the Forest Interests, and the "Preaching of the Gospel" to the General Public. Indeed, it is the activities of the Field Pathologist that protect the status quo and sheltered position of the Laboratory Pathologist.

Under some present methods of evaluation the "Down to Earth" Field Pathologist may find it difficult to compete with the Laboratory Pathologist. The effect is a psychological one which may be expressed by the following quotation from an editorial in Science, 139, No. 3553:

> "Scientists like other human beings are affected by fads. They tend to go with the crowd. The research worker who does not go with the orowd encounters a rather bleak climate. He is likely to be regarded by administrators and laymen as an odd fellow who is not in tune with the times"

The end result may consist in the most accomplished Field Pathologists spending more and more time in the laboratory and less and less in thee field. Surely, the extent of our present knowledge of the many forest influences that affect the incidence of disease would not warrant transfer of a sizeable portion of our research effort to the laboratory. Possibly the term Forest Pathologist should be restricted to those actively-engaged on field problems, and the progress of the Laboratory Pathologists determined not by comparison with the field pathologists but with others of their own kind. This comment is not made in a derogatory manner, since it is fully recognized that the research of the Laboratory Pathologists forms an essential part of work programs, provided that it is coordinated with the field studies.

The Terms Basic and Fundamental Research in Forest Pathology:

For years I have been endeavoring to distinguish between what may be considered as applied and fundamental or basic research in forest pathology. Frankly, I have not found an answer. It would seem clear that many studies classified as fundamental have been conducted at a level of artificiality that results may confuse rather than add to firmly established principles in the epidemiology of diseases. Indeed, consideration of natural phenomena often would appear as the final rather than initial approach in the development of the research. Perhaps at some time we have all encountered the Prima Donna-type of investigator who is unable to undertake research properly because of a lack in facilities and endless items of expensive equipment that are necessary to provide laboratory conditions similar to those occurring in Nature. In many instances it would not seem to be appreciated that most of these requirements are provided by the forest itself, free of charge, and that research on field material might yield results of greater value to the Forester. One senses a feeling of reluctance on the part of some investigators to become actively-engaged on field projects since it may be beneath their dignity as scientists or lead to results that may not be interpreted as contributions in fundamental research. There may be little basis for this type of philosophy in forest disease research.

Macro - and Micro - Environments:

Results of many studies have demonstrated that climatic and site factors of the host may exert a strong influence on the incidence of many pathogens and their parastic capabilities. However, evidence has been presented in different countries which demonstrated that infection and disease development may involve considerably more than the presence of a pathogen, susceptible host tissues, and environmental conditions suitable for infection. Indeed, the tissues of a healthy tree or individual cutting were found to be colonized by numerous microorganisms. Therefore, tissues of healthy trees or individual cuttings should not be considered as entities but rather as a complex biological communities or micro-environments. It may be correct to assume that the microfloras on different individuals of one species or on different parts of a tree, e.g. new growth, may vary considerably, depending upon the number and types of organisms that accidentally reached natural or artificial infection courts, and proved capable of colonizing the living tissues. In any event it has been demonstrated that some saprophytes that occurred on and within the healthy tissues of trees were very efficient individually and collectively in preventing the diseases caused by a number of aggressive pathogens. Preliminary evidence has indicated that production of secondary roots was increased appreciably when the basal ends of cuttings were placed in contact with aqueous solutions containing the tissue saprophytes. Therefore, the presence and activities of these organisms may have exerted beneficial influences on both growth potential and level of disease resistance of trees. It would seem possible that part of the variation in growth and disease vulnerability that occurs between individuals of a species and, indeed, within clonal material harvested from one root system, may be related to the specific microbiological floras that have become established on and within the above ground parts of trees. Therefore, it may be necessary to broaden our thinking in terms of phenotypes, genotypes, and microbiological types in trees.

In studies to determine the effects of the nutritional and/or antimicrobial properties of healthy tissues on the development of a pathogen it may be of importance to consider the biological community aspect of tissues. The growth of the microbiological floras that occur in Nature on and within healthy and diseased tissues may modify the nutritional properties of tissues and inactivate the fungistatic effect of chemical inhibitors proven to be highly effective against a pathogen in pure culture.

It is felt that the Forest Pathologist should consider the potential effects to be derived from the microfloras on and within the above-ground parts of healthy trees. If certain organisms prove to be successful competitors and antagonistic to pathogens it may be possible to supplement those provided by Nature by application of large numbers of the required saprophytes, and achieve a degree of biological control.

Summary:

Because of some recent trends in the organization, administration, specialization, sophistication, and level of artificiality of some disease research it may not be too soon for Forest Pathologists to promote a "Back to the Forest Movement". As a beginning this might consist in the distribution of posters depicting a closed fist with the index finger pointing, not upward, but horizontally, in the direction of a diseased forest or cutover area, with an appropriate undergrowth of Devil's Club or Salmonberry seven feet high.

A REVIEW OF THE PERTINET FACTS OF FOREST PATHOLOGY IN MEXICC. (REVISED PAPER)

R. Salinas

The first step in Mexican forest pathology was taken, in the year 1900, with the creation of a commission to deal with the problem of parasitology in agriculture which was to include, in its program, ivestigations of the parasites and diseases prejudicial to national forests. This same commission also saw the establishment of what might justly be called the first National Museum of Parasitology and Pathology. Said establishment was directly due to the initiative of the commission's members, in particular to Julio Riquelme Inda, and his collaborators (1905), but whose many efforts have, unfortunately, never been adequately recognized; in fact, they have generally remained unknown.

The next important bit of data tells us that Lapig (1911) made some important suggestions regarding the means of combatting diseases common to the forests of the Federal District.

From Roldan (1917), we have knowledge of a report on mistletoe (Arceuthobium sp.), specifically written regarding parasites and tree diseases, in Mexican forestry literature dedicated to the examination of one single problem. Later (1948), this problem was treated by Solorzano and Pliego.

From 1912 to 1930 there is no record that forest diseases were even so much as mentioned. The majority of publications, including the texts used in forestry classrooms, dealt only with the entomological aspects. It was not until 1942 to 1945 that the phrase "forestry disease" (Ortega Cattaneo y Coll, 1942 - 1945) reappeared in print and the problem was again actually treated with.

Finally, in 1953 and 1954, the most recent references appeared respecting forest pathology. One of these offered for consideration the proposition of forest fires being a responsible agent in the propagation of plagues and diseases (Verduzco, 1953). Two years later another tentative morphlogical study, of pine rusts, that did not arrive at the point of a critical examination of the problem was prepared by Salinas Quinard (1955) and presented to an international conference held at Banff, Alberta in 1961.

The foregoing amply demonstrates that references to Forest diseases are substantially scarce on the Mexican scene, in both laboratory reports and national forestry literature. It shows, also, that the few references at hand have been presented sporadically over a considerable lapse of time. Certainly there has been no progressive continuity, nor is it possible to formulate an orientated estimation of forest diseases. Moreover it is impossible to estimate, from what few reports are at hand, the danger these diseases represented and represent in any forested area.

The admissive reasons, which in my opinion are responsible for the scarcity of pertinent data are:

It was the direct responsibility of the National School of Agriculture, considering that in 1900 it had accumulated a half century of experiences, to train and prepare the technicians to deal with forest diseases; and, the commission of agricultural pathology could have demanded such an action in support of its forestry program. This however was not done.

The separation of the National School of Forestry in 1910, for the purpose of preparing specialists, andforestry guards, did not give sufficient attention to the disease problem, in spite of the fact the experiences of the afore mentioned commission gave every reason to do so. Neverthless, it is only fair to recognize that the first enthusiasts to push the question of forestry disease to the fore were members of this institution, enthusiasts, incidentally, who were largely self-instructed in pathological studies. The difficulty was, however, that these self-instructed had to use foreign references which, naturally enough, did not deal with the Mexican forestry problem.

The establishment of a forestry specialized course, in the National School of Agriculture, failed also to resolve the problem due to the fact that, at least until 1962, forest pathology was nothing more than a complementary course to that of parasitology (Entomology) and there are no indications to date that the students of this subject matter have ever been active in the forest pathological field.

The reorganization of an institute, especially dedicated to forestry investigations (Investigaciones Forestales, 1935), could have given reason for the different Technical institutes in the country to establish courses in forest biology as the biologists and bacteriologists of the National Polytechnical Institute formed part of the initial corp of workers in the Instituto Mexicano de Investigaciones Forestales, but there has never been a coordinator appointed who was qualified as a forest pathologist.

Until 1954, the general condition of forest pathology in Mexico could be summed up by the simple fact that in one single laboratory, one worker, who was not a qualified pathologist, was responsible for the solution of all alleged forestry problems. Naturally, the responsible undertook to inform himself through foreign literature and an insufficiency of personal observations, in order to define, if only theoretically, the three fundamental categories of possible known and suspected problems. These three basic categories would be:

(1) Nursery activities
(2) Forest Research
(3) Wood technology

The fact that Mexico did not yet have established forest nurseries nor a fixed technological work program, finally led to focusing national attention on forest programs and problems. This, in turn, led to the establishment of three programs of study: rust, fungi that destroyed standing timber, and the mistletoes in general. These programs attempted a basic comprehension of the aspects of localization, diagnosis, and distribution, without going deeply into the question of experimental observations, and without any pretension of analyzing the problems to the end of determining probable solutions.

Actual Trends and Changes In Objectives:

With the reorganization in the Instituto de Investigaciones Forestales, the programs took on wider perspectives and consequently new forms and work plans. Thus the laboratory of Mycology, in collaboration with similar laboratories of the National Polytechnical Institute and the National University, and with companion laboratories within the same forestry institute, initiated preliminary studies: a) in native soils of the tropical forests (1962) plus experimental observations related to damping-off and its chemical control (1962-63): b) initiated studies (1963) relative to the morphology of fungi: c) made ecological research (1962-63) of such fungi as the mycorrhizic, wood destroyers and rust; and of mistletoes.

As a consequence of international agreements between the North American countries; Canada, United States, and Mexico, it has been pointed out that there is an urgent need for Research and Experimental Investigation in the field of forest pathology; that special attention must be given to such factors as localizations, distribution, and impacts actual as well as potential. Also it must be known how all these affect each; individually and collectively.

Historical antecedents demonstrate that Mexico is not yet capable of dealing with all of the pathological problems derivative of its some sixty millions of acres of forests; and thus must limit its activities to dealing with those diseases most widely spread, while taking into account that these may pass the frontiers of her neighbors, might have, in fact, originated in those countries.

With respect to her collaborators, Mexico suffers a disadvantage, the disadvantage of not being able to cooperate adequately, nor efficiently. Furthermore considering that she cannot rapidly solve problems, which remained unsolved because of the acute lack of trained pathologists, it is necessary to establish specific arrangements that will permit this country to better its possibilities by:

(a) Its two companion countries and probably Guatemala may be included sustaining one or two Mexican candidates while receiving specialized instruction; or (b) sending Canadian or American pathologists to Mexico for the specific purpose of collaborating and instructing in field methods of investigation, and experimentation, thus working with the trainees in the environment where the problems exist.

In my opinion either, or both of the two alternatives offered, would be the effective and a producer of lasting benefits. Above all, it, would lead toward the discovery of common problems, and to the use of common solutions, and thus eliminate much duplication of research activities.

If some arrangement cannot be made, such as one of those suggested or some other satisfactory means worked out, Mexico will solve its problems according to the few resources at its command and the collaborating countries will have to make their own observations within Mexican territory, until such a time as forest pathology reaches a stage of development such as will permit Mexico to do her duty as a full collaborator.

Meanwhile, it is perfectly evident that Mexico, within the mechanism of the working Groups of the North American Forestry commission, will hold only an honorary position, or will have to retire temporarily thus taking a definite step backward, both regarding its forestry development programs and its international policy of collaborating with other countries in all that contributes to international harmony and betterment.

Resume:

First efforts to deal with forest disease were initiated in Mexico with the naming of a commission in 1900. This commission did little other than establish a National Museum of Parasitology and Pathology, and this, due largely to the little recognised efforts of Julio Riquelme Inda and collaborators (1905).

Until 1930 there is little to indicate that there was either interest or activities in the field of forest pathology, outside of two papers; one by Lapig and the other by Roldan (1911).

History of antecedents demonstrate Mexico's incapacity to solve her problems in such a manner as will allow her to collaborate fully with her sister countries, Canada, the United States, and Guatemala, whom she has joined in a common fight against forest diseases. The cause of her obvious incapacity is a dire lack of skilled technicians. This situation can be corrected only by special concessions being granted to the end that cooperation be practiced in the training of such Mexican technicians as are needed.

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MULTIPLE USE ADMINISTRATION ON THE TETON NATIONAL FOREST

H.H. Van Winkle, Forest Supervisor
Teton National Forest
for
The Western International Forest Disease Work Conference Field Day
September 12, 1963

It is a pleasure to meet with you and review with you multiple use administration on the Teton National Forest, especially as it is related to activities centered in the nationally famous area. The passage by Congress of Public Law 86-517, known as the Multiple Use Sustained Yield Law, in 1960, has proven to be a significant event in our administration.

Multiple use management means "The management of all the various renewable surface resources of the National Forests so that they will be utilized in the combination that will best meet the needs of the American people, making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to the changing needs and conditions. That some land will be used for less than all of the resources and harmonious and coordinated management of the various resources, each with the other without impairment of the productivity of the land, with consideration being given to the related values of the various resources and not necessarily the combination of uses that will give the greatest dollar return for the greatest unit output".

Sustained Yield of the several products and services means "the achievement and in perpetuity of a high level annual or periodic output of the various renewable resources of the National Forests without impairment of the productivity of the land. This Act of Congress gave favor to the development of planning on the National Forests.

In the Intermountain Region of the Forest Service an area comprising Southern Idaho, Western Wyoming, Utah, Nevada and small parts of California and Colorado, we have separated the Region into seven sub-regions. Each sub-region comprises those national forest areas with fairly similar management situations. For example, the Snake River-Green River Subregion is composed of the Teton and Bridger National Forests, plus the north slope of the Uinta Mountains in the Ashley and Wasatch National Forests.

The subregions in turn are generally divided into broad management areas. The Crest Zone, the high country located in sub-alpine timber country or above timber line, the Lower Slope Zone, the area lying below timber line and usually devoted primarily to grazing purposes; the Intermediate Zone - the area located between the Crest and Lower Slope Zones and the major land area wherein the dominant cover is commercial timber, often interspersed with grazing lands, but where most timber harvesting takes place and Special Zones such as Wilderness and Primitive Areas. There are two other zones of variable width, called Travel and Water Influence Zones. The Travel Influence Zone follows routes such as roads or trails. The width may vary from as little as 100 feet to as much as a mile. Only those routes important for travel or scenic recreation values have been designated as Travel Influence Zones adjoining these routes. Thus many miles of road and many trails do not have Travel Influence Zones.

The Water Influence Zone is limited to areas adjacent to lakes and fishable streams. They also vary in width. The zone often overlaps the Travel Influence Zone. Within the Travel and Water Influence Zones are located practically all of the recreational developments. There may be some minor developments outside of these two zones, but they will be few.

Management directions found in the Subregion Guides represent the policies the Forest Supervisor and District Rangers follow in preparing multiple use plans for a Ranger District. Functional plans for resources such as timber, recreation, forage and wildlife must fit into the multiple use plans.

In order to assure the proper multiple use coordination is effected in managing National Forest lands, we have been charged with the responsibility to conduct multiple use surveys for the purpose of evaluating the effects of both in-service and out-service proposed development projects upon the protection and use of the National Forest resources. Specific conclusions and recommendations following the surveys are used for requirements in permits, easements, licenses or agreements.

We are now standing upon the Curtis Canyon View Point. The National Elk Refuge lies in the main valley bottom against the foothills between the Teton National Forest and the Grand Teton National Park, and it extends as far north as the Gros Ventre River. Further to the west are several privately owned ranches, which depend in part for summer grazing on the Teton National Forest. The Grand Teton National Park extends along the west side of Jackson Hole. All of the streams of this important water source area at which we are looking flow into the Snake River. The Yellowstone River originates in the northeast section of the Teton Wilderness Area and is a part of the Mississippi River drainage. All of the local streams have extremely important fishery values, as a matter of fact, we have more than twice as many fishermen visiting the forest each year as there are big game hunters. Many of the big game animals spend all or part of the winter on range lands set aside as game winter range. For example, no livestock are grazed on the National Forest immediately east of the Elk Refuge here or on certain areas south of where we are standing. A large portion of the elk herd spend the winter on the National Elk Refuge, and at supplemental feeding stations operated by the Wyoming Game and Fish Commission. Some of the deer, moose and big horn sheep depend almost entirely on open range yearlong.

Big game hunting for all practical purposes is limited to National Forest lands. Sport hunting and fishing provide a lot of outdoor recreation and results is an annual removal of game animals that is desirable if wildlife is to be maintained in balance with the available habitat.

The major portion of the recreation use on Teton National Forest is a dispersed type of recreation closely associated with the big game and fish resources. It is estimated that sixty percent of the total recreation use on this forest is of a highly dispersed type. This use extends over areas of rangelands grazed by domestic livestock as well as game animals. It is all located on important water resource areas. It includes areas of commercial timberlands and over one half million acres classified as wilderness. The National Forest ranges provide grazing for about 16,000 head of cattle and 11,000 head of sheep and 2,000 head of recreation pack and saddle stock annually.

We have six localsawmills in the vicinity of the forest which have been cutting from five to twelve million board feet of commercial timber annually.

The local pattern of several types of Federal land ownership each administered by distinctive policies of land management make National Forest land management more complex. It is apparent that whatever action is taken on any one large area of land, influences and in turn is influenced by what occurs on the other lands. Understanding and cooperation between the various agencies is therefore essential if each of them is to do their own job successfully.

REGION FOUR'S COMANDRA

Rust Problem and Approaches to its Solution.

The second part of the Field Trip dealt with the Comandra rust problem in lodgepole pine and was conducted by Mr. Dick Krebill and Roger Peterson. There was lively discussion and the epidemiological and "impact" aspects of the rust problem were emphasised.

ONTOGENY AND CYTOLOGY OF THE NORTH AMERICAN SPECIES OF THE HYPODERMATACEAE ON CONIFERS

Clancey Gordon

The Hypodermataceae have been placed by different authors in the Phacidiales, Hysteriales, Hypodermatales or Helotiales. Those species of Hypodermataceae affecting conifers are called "needle-cast fungi"; they are worldwide in distribution. Since G.D. Darker's (1932) monograph "The Hypodermataceae of Conifers"there has been no widely accepted taxonomic revision of these fungi. The only attempt to revise any genus of the family was Tehon's rearrangement of Lophodermium which has been accepted by only a few mycologists. Our present day knowledge of sporocarpic development is based to a large extent on work carried out by Darker and S.G. Jones (1935) on Lophodermium pinastri; by Tehon on Lophodermium spp. (1934); by Charles Waters (1958-60) and by P. Sikorowski and L. Roth (1962) on Elytroderma deformans. The lack of our knowledge on the more than 50 species occurring on conifers is demonstrated by the extremely inadequate coverage of this group in J.S. Boyce's (1961) Forest Pathology in which only 7 pages are devoted to the needle-cast fungi. Gäumann (1928) and Bessey (1950) each devote but 1½ pages to the entire order in their respective books on the morphology of the fungi.

Some of the earlier contributors to our knowledge of these fungi are: Hartig (1874), Rehm (1896), vonTubeuf (1901), Lagerberg (1910) Mer (1910,12), Haach (1911), Weir (1916), von Höhnel (1917), Killian and Likhite (1924), Dearness (1924), Nannfeldt (1932). All these contributions base the taxonomy of the group primarily on morphology of ascospores. There is less known about the ontogeny of the sporocarps within this family (Hypodermataceae) than in any comparable group of Ascomycetes. The life cycles of all but 2 species (Lophodermium pinastri and Elytroderma deformans) represent a virgin field for study.

In personal correspondence with G.D. Darker (May 15, 1962) concerning my interests in the ontogeny of the species of Hypodermataceae he states, "Development studies are still needed for most species. Cytological studies are difficult and Jones' work with Lophodermium pinastri still remains the best that we have". S.G. Jones published his work in 1935, many years before phase microscopy became common. His written report and camera-lucida drawings are very impressive because of the intricate detail with which he describes the function of the spermogonial stage (pycnidium). He also describes the development of the trichogyne which, according to him, is formed between the spermatophores of the spermogonia. The development of the hysterothecium from the primordial stage to maturation is minutely described and illustrated in Jones' paper. Since Jones' work is the "best that we have" and is concerned with only one species, it seems we are in dire need of further investigation of these fungi. There is a great need for a renewed survey of these fungi with modern tools and using different criteria. Of the over 500 specimens so far examined, my research shows the majority misidentified. The previous misidentifications are probably the result of using ascosporic size, primarily, as the main criterion for identification (Tubeuf, Dearness and Darker). As an example, Lophodermium pinastri found on Pinus sylvestris in Europe and identified by such mycologists as H. Rehn, H. Sydow, and F. Petrak, does not occur on 3 and 5 needle pines in the United States, as reported by Darker. These misidentifications are due to the fact that ascospores produced by L. pinastri have almost the exact measurements of 2 other fungi (undescribed) which do occur on 3 needle and 2 needle pines (e.g. Pinus ponderosa and P. jeffreyi; P. contorta and P. banksiana). Lophodermium nitens also has been consistently misidentified as L. pinastri even though the latter does not occur on 5 needle pines.

The location of the ascocarps within host tissues, as designated by Darkers' monograph, frequently are incorrect. The ascocarp of Lophodermium decorum is located intra-epidermally rather than subepidermally, and I am sure this is the same fungus that occurs in the eastern part of the United States on Abies balsamea which Darker named L. lacerum. Also, L. durilabrum develops intrahypodermally rather than subepidermally. I have collections of the above fungi identified by Darker.

Tehon uses the characteristic "Hysterothecia with a chitinized aliform plate forming the outer layer of the cover and the bottom layer of the base" to delimit 2 new genera in his rearrangement of Lophodermium. My examination of some of the same collections as used by Tehon indicates that the upper chitinized layer consists of a single-layered hyphal mat and the remains of the crushed "condiophores" of the "conidial" stage.

I make this criticism only to emphasize the importance and real need for complete revision of concepts concerning these fungi.

HYPHAL CHARACTERISTICS OF CERTAIN FUNGI IN WOOD

J.W. Roff*

The diagnosis of decay in timber based upon microscopic characteristics of hyphae seen in wood is not reported to the same extent today as it was formerly. The change has come about largely because of the more general use of artificial media and of laboratory techniques which lead to identification of fungi in vitro. As a result, examination of wood sections is of greatest value to the pathologist now in determining the type of fungal infection and the degree of deterioration which is present.

While a number of criteria may be established for recognition of species, presence or absence of certain features may usually be applied only in a positive sense, owing to the habit of fungi. In this way for example, while the occurrence of mycelium, bore holes or eroded pits in the wood may evidence decay, the absence of one or all of these does not necessarily infer that the specimen is disease-free. Similarly, while the occurrence of clamp connections upon hyphae confirms the Basidiomycetes, these structures are not produced regularly and in fact not at all in the case of many of these fungi so that the absence of "Buckles" is of little significance and does not serve to deny possible occurrence of this class of fungus.

Because of the diverse growth reactions which may be obtained when fungi attack wood, a degree of variation in their morphology, as reported by different workers, is to be expected. At this laboratory, however, workers have encountered what appears to be a faulty interpretation of observations, the details of which are the subject of this paper.

Examination of sections taken from dark coloured heartwood of western red cedar (Thuja plicata Donn) commonly reveals hyphae of various types within the wood. The more obvious are unbranched and upwards of three microns in diameter. They often proceed more or less at right angles to the tracheids and are sharply constricted where they pass through walls. This habit has been reported by McCready (2) to be typical of Poria Weirii Murr. in cedar. The fungus is a common cause of decay in the tree and produces a yellowing of the wood in the incipient stage.

As this general appearance and lack of branching of the mycelium is not commonly seen here with the Basidiomycetes and also owing to the apparent anomalous association of this fungus with brown rather than with light colorations in the wood, we carried out a number of tests employing different strains of P. weirii. These were transferred in soil jar cultures to uninfected blocks of western hemlock, Tsuga heterophylla (Raf.) Sarg., yellow cedar, Chamaecyparis nootkatensis (D. Don) Spach, and red cedar. Sterilization was by momentary dipping of blocks in boiling water.

The fungus grew readily and a yellow, bleached zone appeared in cedar blocks where decay was more advanced. Significant weight losses occurred in all species but when blocks were sectioned no evidence of the non-branching transverse type of hyphal development, said to be typical of P. weirii, was found. Within the wood, fungal growth was profuse, mycelium was fine and proliferated randomly without respect to alignment of tracheids. This condition was immediately typical of that seen in other wood material infected with any of a number of Basidiomycetous fungi employed here in previous tests.

Pathologists who have studied western red cedar are acquainted with the difficulties entailed in the isolation of organisms from this durable wood and it is apparent that McCready's original identification which has been quoted widely, was based upon the presence of decay and not specifically upon cultures made from the wood which exhibited the type of mycelium which he depicts. Specimens of cedar forest products in which the coarse, unbranched and constricted hyphae occur usually yield a mixture of organisms in culture upon agar media, including yeasts and the fungi which exhibit scanty, appressed growth associated with Fungi imperfecti. Recently we were successful in isolating one of these (resembling Cladosporium sp.) which on transfer to western red cedar produced a noticeable darkening in the wood. We have also observed the mycelium of other imperfects, e.g. Sphaeropsidales in yellow cedar and Moniliales in true fir (Abies amabilis Dougl.)Forb.) which develops in the lineal unbranched manner described above. A similar aspect has also been reported for Alternaria tenuis in basswood (3).

In tests in vitro we have demonstrated that P. weirii causes a yellowing of cedar wood and produces mycelium within the structure which is usually fine and branches freely throughout the tracheids. Basidiomycetes other than P. weirii may also occur in cedar (1) but their mycelial structure is similar to that of others in this class. Unbranched, coarse hyphae which prefer to cross tracheids at right angles and tend to constrict where they pass the walls are found in dark-coloured cedar heartwood but this is associated both in agar culture and in block culture tests, not with P. weirii but with species of Deuteromycetes.

While it may be possible to separate decay-producing fungi in wood from the non-decay producers, using hyphal characteristics as seen in wood sections, cultural tests are usually necessary to identify the species. In one instance, however, we have noted hyphae which exhibit double clamp connections in infected wood. These sections were from log material, also in laboratory test material infected with the Basidiomycete, Stereum sanguinolentum. Clamp connections of this type occur less frequently in wood than in agar cultures of the fungus but we believe when seen in softwoods they are specific and serve to identify the organism. This siutation is unique in our studies of wood-inhabiting fungi.

In conclusion then we have noted that hyphal characteristics of fungi seen in wood sectio.s are of limited value for identifying species. In cedar, however, the Deuteromycetes proceed radially through wood and have coarse, unbranched hyphae. The Basiodiomycetes including Poria weirii, produce mycelium which is much-branched and extends at random throughout the wood.

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Research Officer, Vancouver Laboratory, FPRB

Department of Forestry of Canada, Forest Products Research Branch Contribution Number.

ROOT DISEASE SURVEY OF BLOWDOWN TIMBER NORTHERN CALIFORNIA - 1963

Douglas R. Miller

The windstorm that occurred October 12, 1962 blew down varying numbers of living trees in numerous forest areas throughout Northern California. The old saying, "It is an ill wind that blows no good," can be aptly applied as the roots of the windthrown trees offered an excellent opportunity for a surveyof root diseases.

With a survey in mind the natural question to be answered are:
1. What percentage of the windthrown trees supports root diseases?
2. What percentage of the diseased root systems are weakened to the point that they were more prone to wind damage than undiseased trees?
3. Which root diseases are present?
4. What is the extent and distribution of each disease found?

The Division of Timber Management of the U.S. Forest Service at San Francisco decided to conduct a small scale survey in an effort to gain information relating to the four questions. The methods of making the survey and the records to be kept were worked out with members of Forest Disease Research at the Pacific Southwest Forest and Range Experiment Station.

Since the scope of the work was limited by funds and the availability of technical personnel it was felt that the purpose of the survey could best be served by directing the sampling to known areas of blowdown. For these reasons it was not feasible to select study areas by random methods that would permit evaluation of data by predetermined confidence levels.

Sampling was confined to areas on the Lassen and Shasta-Trinity National Forests as these encompassed the greatest damage. To increase the number of trees that could be examined under those conditions, the survey was restricted to areas readily accessible by road. An effort was made to space the plots so as to sample different timber types in each of the broad areas of both forests. The plot areas were selected after conferring with Forest personnel --I might add that late snows rendered many roads impassible and most of the others hazardous from the mud standpoint.

All data was recorded in code to be summarized on an electric computer. The data for heavy blowdown areas and that for light blowdown areas were kept separate. Heavy blowdown was defined as areas having a high percentage (at least 15-20 percent) of the trees down and where 25 to 100 could be examined while moving only short distances between trees. An area of light blowdown was one having from one to a few trees down at a place and under these conditions a plot consisted of a predesignated distance along a road, a drainage, a ridge top, etc.

The following data was recorded--as has been previously stated--in code. Forest, County, growing site, elevation to the nearest 100 feet, type of blowdown (scattered or concentrated,) whether cutover or uncut before blowdown occurred, if cut the year of operation, tree species, number of trees examined, diameter of each tree to the nearest 2 inches, aspect, slope, soil texture, presence or absence of basal wounds and the cause if a wound is present, presence or absence of a root rot or rots and the identity if possible, the criteria used to identify the rot, size of infected roots, percentage of visible roots that were infected, whether a tree was in a group of blowdown of 3 or less or a group of 4 or more, distance to the nearest stump or to the nearest windthrown tree that was present before October 12, 1962, and the number of trees (by size class) that had died during the 5 years previous to the time of blowdown.

The survey is still going on whenever we have a few spare minutes when passing some blowdown. This portion of the survey is not confined to the Forests originally set up in the work plan. As a result of this continuation the data have not been summarized on the IBM.

At the time this preliminary summary was made the roots of 1,956 trees had been examined. Since then about 150 more trees have been added. The roots on some trees were intact and well exposed, some were intact but almost completely encased in shale, lava, granite or heavy soil; the roots of other trees were mostly in the ground, either broken off and left there or they were still attached to the tree trunk but hadn't been pulled from their original position. Therefore, the roots of all trees were not examined with the same degree of intensity.

In examining the roots of a tree, we looked for sporophores, dead and rotten roots, rotted bole bases, rhizomorphs, and any other symptoms that might be of help.

Five fungi were considered as primary root diseases or root rots, namely: Polyporus schweinitzii, Armillaria mellea, Fomes annosus, Verticicladiella wagenerii and Poria weirii. Rots without positive identifying criteria were listed as unclassified and where possible samples were collected for culturing in the laboratory. Many of these samples proved to be so badly contaiminated with secondary fungi that the primary pathogen was lost. Other samples revealed wood rotting fungi such as Polyporus abietinus, Pholiota adiposa, Lentinus lepideus, Fomes pinicola, Polyporus sulphureus, a Stereum, and others yet unidentified. Undoubtedly many of these and others were present on trees from which no samples were collected. Of the five primary root rots Poria weirii has never been reported in California and was not found so far during this survey. No specimen of Verticicladiella was found.

Results:

Data were taken on 18 plots on the Lassen National Forest and on 22 plots on the Shasta side of the Shasta-Trinity National Forest. Of the 1,956 trees examined 805 were on the lassen and 1,151 on the Shasta.

Of the 1,956 trees examined 1,134 or 58.0 percent had one or more identifiable root disease present. Thirty-three or 1.7 percent of the total had Polyporus schweinitzii, 969 or 49.5 percent had Armillaria mellea, one or 0.05 percent had Fomes annosus and 140 or 7.2 percent had an unclassified root disease (much of which was suspected of being F. annosus).

The percentage of visible roots affected varied from 1 to 100 percent. Trees having over 5 percent of their root system damaged were considered to be more prone to windthrow, under a given set of conditions, than trees with less than 5 percent damaged. This means that 25.6 percent of all the trees examined had enough root damage present to attribute toward their being blown down.

Table 1 shows the number of trees examined by species, the number of trees affected by a given root rot and the number of trees by percentage class of damaged roots.

Table 2 gives the percentage of the total trees infected with each root rot.

Table 3 shows the percentage of diseased trees infected with each root rot.

Table 4 gives the percentage of the total trees classified as to amount of root damaged.

Table 5 presents the percentage of diseased trees classified as to amount of roots damaged.
Table 6 shows for each tree species the number examined and the number and percentage of those having a root rot.

TABLE 4

PERCENTAGE OF TOTAL TREES CLASSIFIED AS TO AMOUNT OF ROOTS DAMAGED

Total trees exam.	Less than 5%	5% -10%	11% -20%	over 20%	Total
1956	32.4	6.6	4.2	14.8	58.0

TABLE 5

PERCENTAGE OF DISEASED TREES CLASSIFIED AS TO AMOUNT OF ROOTS DAMAGED

DISEASED TREES	LESS THAN 5%	5% -10%	11- 20%	over 20%	Total
1134	55.7	11.4	8.3	25.6	100.0

TABLE 6

NUMBER OF TREES EXAMINED, NUMBER AND PERCENTAGE OF THOSE HAVING A ROOT DISEASE BY TREE SPECIES

TREE SPECIES	TREES EXAMINED	DISEASED TREES	PERCENT OF TOTAL TREES DISEASED
Douglas-fir	234	88	37.6
Ponderosa pine	247	84	34.1
Jeffrey pine	6	3	50.0
Sugar pine	144	54	37.7
Lodgepole pine	48	17	35.4
Knobcone pine	5	4	80.
White fir	1203	857	71.1
Red fir	26	16	61.5
Incense-cedar	43	11	25.6
Total	1956	1134	58.0

TABLE 1

number of trees by root rot
by percentage of damaged roots
by tree species

TREE SPECIES	Trees exam-ined	ROOT ROTS PRESENT					Number of trees by perentage of damaged roots.				
		P. schw.	A. mellea	F. annosus	other	Total	less 5	5-10	11-20	over 20	Total.
Douglas-fir	234	15	64	—	12	91	57	11	4	16	88
Ponderosa pine	247	7	53	1	25	86	5	11	7	11	84
Jeffrey pine	6	—	2	—	1	3	2	1	—	—	3
Sugar pine	144	6	42	—	9	57	39	4	6	5	54
Lodgepole pine	48	2	14	—	1	17	12	2	—	3	17
Knobcone pine	5	-	4	—	—	4	4	—	—	-	4
White-fir	1203	3	772	—	82	857	448	92	63	254	857
Red-fir	26	-	12	—	4	16	9	7	—	-	16
Incense-cedar	43	—	6	—	6	12	6	1	3	1	11
Total	1956	33	969	1	140	* 1143	632	129	83	290	1134

* Each of nine trees had 2 root rots present.

TABLE 2

Percentage of total trees having a given root rot.

Total trees examined	P. schw	A mellea	Fomes anno.	other	Total.
1956	1.7	49.5	0.05	7.2	58.5

TABLE 3

Percentage of diseased trees having a given root rot.

Total trees diseased	P. schw.	A. mellea	Fomes anno.	other	Total
1143	2.9	84.8	0.1	12.2	100.0

COMANDRA BLISTER RUST OF LODGEPOLE PINE: INFECTION OF BY BASIDIOSPORES

E.A. Andrews.

Comandra blister rust of lodgepole pine is much like white pine blister rust in many respects. The symptoms include the brown flags of needles that have died recently, dead tops and dead trees. Aecia and spermagonia in the infected bark sporulate in July and August in the Northern Rockies but the portions of the bark containing the latter lack the "pycnial scars" that are symptomatic of white pine blister rust.

Cross-sections of hymenia of aecia and spermagonia are typical of both fungi but the large size and pronounced pyriforme shape of the aeciospores distinguishes Cronartium comandrae from all other rust fungi. About 50 years ago Hedgcock and Long used aeciospores from Pinus pungens to infect Comandra umbellate obtaining uredia as evidence that the fungi found on the two hosts were identical.

Within a few weeks telial horns develop in the same pustules and when the teleutospores germinate to produce promycelia and basidiospores the horn changes color from a dull brown to a yellow bloom. The promycelia give rise to the basidiospores on very prominent sterigmata. These spores were the inoculumused in this work to infect lodgepole pine seedlings growing in pots in the greenhouse.

Collections of Comandra pallidabearing mature telial horns were placed above and among the needles of the seedlings and held in a moist chamber for about three days until the yellowish bloom on the horns indicated that basidiospores were being produced. Fourteen months later some of the inoculated seedlings developed drops of brown liquid on the surface of the bark that contained spermatia. A section of the bark revealed the hymenium typical of a spermagonium of Cronartium comandrae.

At present attempts are being made to section bark of lodgepole pine so that infectious mycelium can be distinguished clearly from host cell walls and other tissue components. Boiling sections for ten minutes in a saturated solution of chloral hydrate containing acid fuchsin is giving some promise in this respect. Eventually it will be very valuable to be able to determine whether or not the fungus is living. Although the production of aeciospores is the most obvious evidence of infection in the bark of lodgepole, the presence or absence of living, haploid, perennial mycelium is the true measure of the effectiveness of any control efforts.

APPENDIX I

NEW TECHNIQUES

A PLAIN MAN'S GUIDE TO ELECTRONIC DATA PROCESSING

W.B. Kendrick
Plant Research Institute, Central Experimental Farm, Ottawa, Canada

Electronic computers are, to those unfamiliar with them, alien, almost frightening creatures. I am going to try to discuss them simply and practically and perhaps strip away some of the cloak of mystery which surrounds them.

Computers are often thought of as completely new tools with which to approach existing problems. It seems to me, however, that many of our problems are also in fact relatively new, and that we should accept computers as technologically merely keeping pace with the expansion in many other fields of knowledge. A few unfamiliar figures may illustrate one aspect of the problem.

About 250,000 publications dealing with fungi have already been published, and additions are now being made at the rate of almost 7,000 a year. These are scattered among books and 2000-3000 scientific serial publications. You may think that is a large number of journals. I can add that the total number of scientific journals now being published is about 25,000. Further, this number is being added to at a rate now approaching one thousand each year -- almost three a day. That is a sobering thought.

If we remember that papers are now, for a variety of reasons, shorter than ever before, and lists of authors longer (for example a recent one-page bacteriological note in Science had 15 authors -- a world record?) we are led to the inescapable conclusion that we are facing what may literally be called an "Information Explosion", precipitated by an ever increasing number of scientists and their ever more elaborate data-gathering machines (of which the artificial satellites and space probes are probably the most sophisticated).

Storage of this flood of information is scarcely possible using the scientific journal -- collation and retrieval are simply out of the question. We are willy-nilly working and writing ourselves into the hands of the computers. Fortunately these strange creatures, while of fearful mien and reputation, turn out on closer acquaintance to be docile and flexible beings, and can be housetrained with a little patience.

Data processing is in itself no new thing; human brains have been doing it with varying degrees of efficiency for a long time, but at a very limited rate. When applied to machines, however, these words have come to mean the extremely rapid and accurate processing of pre-collected data in a predetermined way. The machine is not asked to think about the data and be intuitive or deductive; it is merely asked to treat the data fed into it in a given manner. The information is no more comprehensive than the perception of the person who collected it, and the processing is no more intelligent than the person who designed the machine or programmed it. The main advantage of data processing techniques then, lies not in their brilliant originality but in the speed and accuracy with which large amounts of information can be treated. The IBM 701 computer could complete the eight million calculating steps required in the solution of a differential equation in aircraft wing design in a few minutes -- the same equation would take a man with a desk calculator seven years. Some of the newest computers are at least one hundred times as fast as the 701. In other words the machines are able and willing to take anything we can throw at them.

Let's take a look at a Data Processing System. As our example we'll use the IBM 1620 system which uses punched cards; a versatile machine, characteristic of the smaller computers produced by various manufacturers today.

First the punched card. This is simply a rectangular card in which holes are punched. There are eighty vertical columns, each of which will accommodate a hole or holes representing a single number, letter or symbol. Numbers are represented by a single hole, letters by two holes, some symbols by three holes. The punched cards represent an almost limitless 'library' or 'memory' for the system.

All information to be fed to the computer must be punched into these cards. Basically three types of cards are involved in a 'run' of the computer system. <u>First</u>, the program deck of cards, on which the detailed instructions for the computer are punched. <u>Second</u>, the data deck of cards, which contain all the information to be processed. <u>Third</u>, blank cards which will be punched by the machine during processing and form the 'output' or answer.

Card punching machines have a keyboard which is essentially the same as that of a typewriter. Anyone can use it, from a steno down to a two finger pick and peck scientist. Many punching machines can print above each column the letter, number or symbol requested by the hole or holes in that column. These machines will also, at the press of a button, duplicate any part or all of a previously punched card.

Now we'll assume that you have a program. (This in effect is just a list of instructions for the machine, and programs for many types of problem are now available 'from stock'). We'll also assume that you have your data coded and punched on cards in accordance with your program's requirements. Now let's see how the machine operates

You don't need to stand dazzled by the array of lights flashing on and off, or the numerous buttons. If you have to, you can operate this machine with less difficulty than a beginner may have with a desk calculator. You simply feed your program deck of cards to the input hopper of the system, which reads the cards in sequence. At this stage, the computer may ask you, through its electric typewriter to add one or two items of information such as, 'How many strains are being processed in this analysis?' This you type on the same typewriter. You can see that this typewriter acts as a two-way communication system between the machine and you during processing. The machine will then ask for the data cards which you smartly feed into the input hopper. Then you press the start button on the console. This is normally the only button you'll have to worry about (on the 16-20 it is the largest button on the console.) After this you merely make sure the output punch has an adequate supply of blank cards onto which it punches the answers.

Your next step is to take the output deck of cards, and have them printed out by the printer. This machine scans the cards at up to 150 cards a minute and prints the information contained in each card as a single line of type. The printer is used both to proof-read a program or deck of data cards, and to print out the answers obtained from a 'run' of the computer.

To recapitulate briefly: - we have punched our program and data onto cards, and run them through the machine, which has punched answers onto cards. These answer cards have been printed out. The input and output cards are now permanent records which can be re-used in any appropriate manner. For example, it may be necessary to sort the cards into a new order. This is done very rapidly by the sorting machine which groups cards at a rate varying from 650-2000 cards/minute in any sequence according to any data punched in them. For example, if the answer on each card is a percentage, the cards can be put into order from highest to lowest percentage. The cards can then be printed out again without further recourse to the computer.

Now that you know roughly what the machines do, and how they are operated, lets have a look at some practical aspects. For example, 'Where can I find a computer?' and, 'How much will it cost to use one?' Data processing systems are now widely distributed in Canada and the United States in Universities, Research Institutes and Data Processing Centres, and you should experience little difficulty in locating one. Now for the economics. The usual charge for processing time on a 16-20 is about $25.00 an hour, and, believe me, you can get through a lot of work in that time -- possibly as much as you could do with pencil and paper in several months. Programs for your particular application may be available. If not, you may decide to learn to program (a process requiring more of logic than of mathematics) and 'write your own'. Alternatively you may obtain help from one of the computer firms, who are understandably anxious to sell processing time on their computers.

If you have any present or potential applications of computers in your research I would be glad to hear about them, and will give any assistance I can to those wishing to take the first steps in the use of computers.

One last cautionary remark. The computer may speed the processing of your data, but it will not as yet devise its own research problems, nor collect its own information. These tasks are still delegated to ingenious and long-suffering mankind.

A METHOD FOR PRESERVING BIOAUTOGRAPHIC ASSAYS

A.E. Harvey and S.O. Graham

During a series of experiments involving the location of antibiotic activity on standard and electropharetic chromatograms it came to our attention that the traditional paper, disc plate assay method could be modified in such a way that the original chromatogram could be used as a permanent assay record.

This record is made by preparing an oversize assay plate that will accommodate the entire chromatographic curtain. A developed curtain is placed face down on the surface of the assay medium for a time sufficient to permit diffusion of the antibiotic from the paper curtain to the agar surface. Removal of the curtain and incubations of the plate produces a negative image of the activity. Incubation, in a sealed plastic bag, of the moist chromatographic curtain, on which spores of the assay fungus have now been deposited, produces a positive image. The curtain is then dried and used as the permanent record.

REPORT OF THE INTERIM PROGRAM CHAIRMAN

J.A. Baranyay

The three topics proposed by most of the members for panel discussion in 1964 are:

1. The present status of antibiotics in Forest Disease control.

2. The aspects of biological control of tree diseases.

3. *Armillaria mellea*, a potential threat to western forests?

Other suggestions:

4. Disease, insect relationship.

5. Associative effects of organisms.

6. Influences of environmental factors on fungi and on their host.

7. Mycorrhizae

It was recommended to have a panel with Entomologists and Management men to discuss a unified approach to mutal problems. It was also recommended to have a question period after each paper even if several similar papers are being given, and the business meeting should not be held on the last day.

APPENDIX II

NEW PROJECTS

Washington State University

1. Fungus Flora of the State of Washington and the Pacific Northwest. (C.G. Shaw), H. Saho.

   Objectives:

   1. To collect, identify, describe, classify and permanently preserve representative specimens of the fungi, both parasitic and saprophytic, of the State of Washington and the Pacific Northwest.

   2. To maintain the necessary indices to the Mycological Herbarium of Washington State University and to the mycological literature, particularly that dealing with the host and geographical distribution and taxonomy of fungi occurring in the Pacific Northwest.

   3. To publish the results of the study of the Fungi of the State of Washington in the form of short papers and indices.

2. The isolation purification and measurement of the antibiotic Phytoactin or it's derivatives from treated plant tissues. (S.O. Graham, C.G. Shaw, Alan Harvey, Martin Stoner).

   Objectives:

   1. To develop qualitative and quantitative chemical, biological, or serological assay procedures for phytoactin concentrations in treated plant tissues.

2. To measure the efficacy of phytoactin up-take, distribution and accumulation in plant tissues in relation to environmental and physiological conditions.

3. The Biology and Physiology of Polyporus volvatus. (C.G. Shaw and Harvey Waldron).

Objectives:

1. To study spore dissemination, transmission and the environmental factors favoring infection by Polyporus volvatus; to ascertain the role, if any, therein of insects.

2. To correlate the time of attack by bark beetles and/or other insects with the occurrence of Polyprous volvatus and the decay it causes.

3. To determine the rate of spread of the decay and the amount of decay developing from the time infection occurs until appearance of the fruiting bodies.

4. To determine the sequence and frequency of occurrence of Polyporus volvatus and other fungi, particularly stain fungi, inhabiting the sapwood of logs; to ascertain if by other signs, symptoms, or the use of biological stains, the presence of these fungi can be demonstrated in the absence of conks.

4. Life Cycles of Ascomycetes with Special Emphasis on Cytological Aspects. (Jack Rogers).

Objectives:

1. To obtain photomicrographic and illustrative documentation of nuclear phenomena, especially chromosomal behavior, in the hyphae, sex organs, and sexual products of selected Ascomycetes and to relate evidence to the clarification of sexual patterns and taxonomic problems of the group.

2. To clarify, by means of field inoculations, pure cultures, and microscopic examination of histological preparations, the life histories of certain lignicolous and foliicolous Ascomycetes.

Jack D. Rogers
Washington State University

1. Life cycles of Ascomycetes with special emphasis on cytology:

The investigator will extend his investigations from Hypoxylon Pruinatum to H. Morsci and H. blakei. Developmental morphology of perfect and imperfect stages and nuclear cytology, including chromosomal behavior, will be omphasized.

Currently, we are examining collections of Coniochaeta from wood. We have numerous speoimans from the Inland Empire and from the National Fungus Collections. The present gross morphological studies will be proceeded by cultural and detailed cytological studies.

A graduate student on an NDEA Fellowship will investigate the relationships between some lignicolus Ascomyoetes and Fungi Imperfecti.

2. Foliage diseases of Christmas trees:

Intensive investigations are under way on needle-spotting fungi of particular interest to Christmas tree growers. Several fungi of frequent occurrence are probably not true parasites, but, rather secondary invaders via insect wounds. A major problem involves identification of these foliage - inhabiting fungi, at least one of which is probably a new genus.

NEW PROJECTS

University of California - Berkeley

63-K-1 Development and testing of a sequential sampling procedure for measuring the ribes population of a blister rust control unit.

Objective: To compare the costs and efficiency of the present standard method of regularly spaced strip samples with random plots designed for contract checking work where no information is needed on distribution of ribes and where an appraisal is needed of whether or not a control unit has been worked to specified standards.
(H.R. Offord)

63-G-1 Effect of holding temperature on apparent optimum temperature for growth of heart rot fungi

Objective: To test whether the direction and amount of change in optimum temperature for growth of a fungus depend on the relationship of the holding temperature to the terminal optimum temperature.
(Lee A. Paine)

63-F-1 Spread and intensification of dwarfmistletoe in ponderosa and Jeffrey pines in California.

Objectives: To determine: (1) distance of spread from infected overstory to reproduction; (2) what climatic conditions affect spread; (3) intensification of DM in the reproduction when the overstory is not removed; (4) intensification in the reproduction when the overstory is removed; (5) if there are wave years of infection.

63-F-2 Epidemiology of dwarfmistletoe on firs in California:

Objectives: To determine: if there are differences in susceptibility among members of the same species; the environmental conditions which influence infection; if there are wave years of infection.
(Robert F. Scharpf)

Terminated Projects:

61-G-1 Growth characteristics of heart rots. Temperature response of _Fomes pini_ isolates from Douglas-fir and white fir.
(Lee A. Paine)

57-F-5 The influence of light, temperature, moisture and other factors on the longevity and germination of dwarfmistletoe seeds.
(Robert F. Scharpf)

REPORT ON THE PROJECTS AT THE FOREST DISEASE LABORATORY IN Laurel, Maryland.

Since no report was submitted at the meetings in 1962, those continuing projects of use or of interest to the general membership follow. In cooperation with mycologists, who are concerned with the families of wood-decay fungi, additional isolates being added to the Reference Culture Collection will increase the range of variation within the species and the geographic representation. Additional species of fungi that decay standing and down timber from the major regions of the 49 continental states are being sought. Conscientious and sustaining effort to interest those people who might come in contact with sporophores of basidiomycetous fungi associated with decay of wood in use and wood products is being continued in order to obtain reference cultures useful in the identification of fungi from products. Work on the taxonomy of the sporophores is cooperative and the efforts of the following cooperating mycologists is appreciated: Thelephoraceae; Dr. Paul L. Lentz, National Fungus Collections, Agricultural Research Service, U.S. Department of Agriculture, Plant Industry Station, Beltsville, Md.; (2) Polyporaceae; Dr. Josiah L. Lowe, Department of Forest Botany and Pathology, State University College of Forestry, Syracuse University, Syracuse, New York; and (3) Hydnaceae and Polyporaceae; Dr. R.L. Gilbertson, Department of Forest Botany and Pathology, State University College of Forestry, Syracuse University, Syracuse, New York.

A special effort to secure collections and culture isolations from eastern and western species of the Agaricaceae with the view toward increasing our knowledge of the cultural characters of more species than are now represented in our collections has been begun, thus enlarging our ability to identify those Agarices associated with wood-decay and mycorrhizal formation. The taxonomic services of Dr. Orson K. Miller, Jr., Intermountain Forest and Range Experiment Station, will be sought in the identification of sporophores from which cultures have been made and for the collection of western species in the intermountain region.

Financed by a grant from the National Science Foundation, Dr. J.L. Lowe collected sporophores mainly in the Polyporaceae in Costa Rica during the summer of 1963. The Forest Disease Laboratory at Laurel purchased cultures made from the various collections and portions of the dried sporophores from which cultures had been attempted. These cultures will be studied in conjunction with isolates of tropical and subtropical species occurring in Florida and the other Gulf States of this country. These species are presently little known and both the sporophores and cultures are difficult to identify.

The named isolates in the Reference Culture Collections form the basis for researches conducted by the staff of the Laboratory. Dr. Hazel H. McKay specializes in the study of the Thelephoraceae and Mrs. Frances F. Lombard, the Polyporaceae. Information gained by the study of individual species makes possible the identification of unknown cultures isolated from rot.

The Laboratory continues to furnish identification service to the field pathologists, who make rot isolations as a part of their decay survey studies. In the past two years such identification studies have been conducted on rot isolations from major decay studies on maple and other hardwoods from the Northeastern, Central, Southern, and Lake States, on conifers (primarily) from the Rocky Mountain and Pacific Northwest States, and on products.

In 1962, the Forest Products Research Institute of the Republic of The Philippines requested the assistance of the Laboratory in itiating cultural identification and decay studies in connection with the establishment of a new unit to investigate the decay fungal flora of their native wood species. Mr. Mario A. Eusebio of the Forest Products Research Institute received training and suggestions at our Laboratory in the methods of isolation, maintenance and identification of wood-rotting fungi in culture. A small representative collection of named cultures has been sent to the Institute. Arrangements have been made through Dr. Manuel R. Monsalud, Director of the Institute, for the collection of sporophores and cultures of the basidiomycetous decay fungi native to the Philippine Islands for deposition in our Collections. These will serve as a basis for assisting Mr. Eusebio in his identification of rot isolates from products as well as an opportunity to extend our knowledge of the distribution and variation within species on a world-wide basis for those species common to our two countries.

Additional leaf spot and needlecast fungi are being collected, dried, accessioned, mounted, and added to the Herbarium for future study.

A new study on the physiology of mycorrhizal basidiomycetes was planned, executed, and has been almost completed. Growth was measured by diameter increase on a glucose-ammonium nitrate agar and as measured by dry weight developed on a liquid medium of similar carbohydrate-nitrogen source. Respiration was also measured using a Warburg apparatus. Four measurements were made for 8 temperatures (35 °F, 45°F, 55°F, 65°F, 75°F. 85°F, 90°F, and 95°F) at six-day intervals for 7 mycorrhizal fungi including 2 Boletes and 5 Agarics. The researches should be completed and the data published before the next meeting.

A new study will be initiated in the immediate future to investigate the effect of temperature on development of mycorrhizae on seedlings of *Pinus virginiana* when inoculated with one or more of the 7 fungi previously studied in culture.

Collections of mycorrhizae from woody species endemic in the United States or grown as ornamentals are being made. Collections of mycorrhizae of conifer species native to the Rocky Mountains will be made after the close of these meetings. Ultimately, morphology of the mycorrhizae of each phanerogam species as represented in the collections will be studied and published.

All mycorrhizal researches are conducted jointly with Dr. Edward Hacskaylo, Plant Physiologist, Forest Physiology Laboratory, Forest Service, Plant Industry Station, Beltsville, Md.

The physiology of wood-decay fungi is being investigated using the older clones in the culture collections as well as new isolates made from sporophores encountered by workers in the field. Rate of growth as measured by diameter increase of colonies and dry weight are being measured for 7 to 10 temperatures at 10°F. intervals beginning at 35° F. through 125°F. Carbon and nitrogen metabolisms as measured by dry weight will be investigated. To date 58 isolates of 18 species in 8 genera have been investigated. As soon as statistical design eliminating repeated replication with significance at the 5° level has been completed for liquid culture, dry weight temperature response and carbon-nitrogen metabolism studies will be begun. Initially clones of 3 species of Coniophora, Laxitextum crassum, Panus rudis, Peniophora polygonia, and Polyporus sulphureus will be investigated. These selections were made on the basis of studies completed during the preceding two-year period.

A STUDY OF (OPHIOSTOMACEAE) WOOD STAINING FUNGI IN NORTH AMERICA.

Colorado State University.

The object of this research project is to isolate, study, and describe or re-describe as many species of the genus Ceratocystis and related forms as possible. Isolations and field collections will also attempt to obtain more information on distribution, host and insect relationships and on species inter-relationships.

Investigator: Ross W. Davidson.
Sponsoring Institution: Colorado State University, College of Forestry.
Financed by: National Science Foundation.

FOREST ENTOMOLOGY AND PATHOLOGY LABORATORY

Victoria, B.C.

F. Stem disease - malformations, witches'-brooms, dwarfmistletoes, etc.

Dwarfmistletoe (Arceuthobium spp.)

Objective:

a. To determine the effect of dwarfmistletoe on the growth, form, quality, and rate of mortality of western hemlock, western larch, and Douglas-fir, and to develop damage appraisal systems for these species.

b. To follow the development of dwarfmistletoe from seed to mature plants to determine the critical points of the life cycle and the character and manner in which the environmental factors influence intensification and spread of the organism.

c. To aid in the characterization of the various forms of dwarfmistletoe through cytological, morphological, and host specificity studies.

(Richard B. Smith - Forest Ent. and Path. Lab., Victoria, B.C.)

Deterioration of Douglas-fir Logs:

Objective:

To determine the rate of deterioration of felled and bucked Douglas-fir logs, the fungi involved, and the effect on these of month of felling, log position, and insect damage.

(Richard B. Smith and H.M. Craig - Forest Ent. and Path. Lab., Victoria).

U.S. FOREST SERVICE
San Fransisco

Root Disease Survey of Windthrown Trees: (D.R. Miller)

Objective:
To determine the status of root diseases (kinds, distribution, percentage of trees infected and percentage of damage to individual root systems) in California windthrown trees that existed at the time of blowdown in 1962.

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Moscow, Idaho.

63-K- Evaluation of the effectiveness of cycloheximide and Phytoactin to control blister rust of western white pine. (James W. Kimmey and Jerome W. Koenigs)

Objectives:
To determine the potential of Acti-dione BR and Phytoactin as basal stem sprays and Phytoactin as an aerial spray in killing or in retarding the development of C. ribicola infections in western white pine when used under the most favorable conditions available and using the latest and best proven antibiotic formulations and application techniques.

63-H- Differentiation of live from dead hyphae of Cronartium ribicola. I. Supravital staining. (J.W. Koenigs)

Objectives:
To explore the use of vital staining as a means for discriminating between live and dead hyphae cells of Cronartium ribicola.

63-H- Differentiation of live from dead dyphae of Cronartium ribicola. II. Tissue culturing. (J.W. Koenigs)

Objectives:
To develop a method to culture Cronartium ribicola.

63-H- Differentiation of live from dead hyphae of Cronartium ribicola. III. Respiration in the host-parasite complex. (W.T. Collins)

Objectives:
To determine whether difference in respiratory activity of infected and non-infected tissue can be detected and whether these differences can be adapted to determine whether the parasite in antibiotic-treated cankers is living or dead.

63-H- Differentiation of live from dead hyphae of Cronartium ribicola. IV. Fluorescence Microscopy. (Orson K. Miller Jr.)

Objectives:

To attempt to adapt one of the various techniques used in fluorescence studies to the problem of distinguishing viable from nonviable cells in C. ribicola.

63-K- Translocation of cycloheximide into new growth of western white pine seedlings. (W.T. Collins and J.W. Koenigs)

Objectives:

To determine whether cycloheximide sprayed on 2-year old leaf and stem tissue is translocated to the new growth in sufficient quantities to afford significant protection.

63-K- Affinity of cycloheximide for water. (W.T. Collins and J.W. Koenigs)

Objectives:

To determine to what degree water is capable of extracting cycloheximide from fuel oil so that sufficient additional antibiotic can be added to field mixing tanks to compensate for water which may be present in them.

63-K- A Monograph of the Western Species of the Genus Lentinus Fries. (Orson K. Miller Jr.)

Objectives:

A comprehensive monograph of the species of Lentinus. The recognition of new taxa in this group combined with the absence of systematic cultural studies of the species has generated a need for this study.

63-D- Factors Governing the Rapid Buildup of Armillaria mellea in Conifer Stands. (Orson K. Miller Jr.)

Objectives:

To determine what factors are responsible for the initiation of rhizomorphs and the rapid growth of the rhizomorphs and hyphae of the fungus. In addition, to determine if differences in the growth factors exist in hosts in different vigor states.

63-G- The Nutritional Requirements of Fomes pini. (Orson K. Miller Jr.)

Objectives:

This study is designed to quantify the nutritional requirements of Fomes pini through laboratory study. It is the first in a series of studies aimed at discovering the factors which are necessary to promote rapid infection and subsequent growth of this fungus.

63-H- Epidemiology of Cronartium comandrae.

II. Relation of infection to environment. (R.G. Krebill).

Objectives:

To determine the influence of physical factors on all infective spore stages of the fungus and on host susceptibility.

TERMINATED PROJECTS

53-I-5 Survey of western white pine pole blight. (D.P. Graham)

54-F-2 Spray control of lodgepole pine mistletoe. (J.L. Mielke)

56-D-2 Effect of artificially imposed moisture stress on rootlet mortality of seedlings of western white pine and associate species. (C.D. Leaphart and E.F. Wicker)

56-F-2)
57-F-3) Distribution and damage surveys of the dwarfmistletoes. (D.P. Graham)

56-H-5 Relationship of the spread and intensification of the blister rust disease of western white pine in the Inland Empire area to the microclimate. (M.G. Lloyd)

57-I-1 Rate of progress of pole blight. (D.P. Graham)

58-F-1 Silvicultural control of dwarfmistletoe in the Douglas-fir, lodgepole pine, and western larch types. (C.D. Leaphart)

59-F-1 Development of survey techniques needed prior to dwarf-mistletoe control. (D.P. Graham)

59-K-1 Tests of systemic fungicides. (C.D. Leaphart)

60-K-1 Tests of the efficacy of systemic fungicides on four native rusts and one needle cast fungus. (J.L. Mielke)

61-K-1 Physiological action of antibiotics in tree disease control. (E.A. Schwinghamer)

62-H-4 Effects of broom rusts on fir and spruce Station research note in press. (R.S. Peterson)

APPENDIX III.

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APPENDIX V.

COMMITTEE REPORT ON STATUS AND NEEDS OF RESEARCH ON DWARF MISTLETOES

J.A. BARANYAY, F.G. HAWKSWORTH, C.R. QUICK, K.R. SHEA,

and J.R. PARMETER (Chairman)

Highlights of 1963 Research

I. Taxonomy, Hosts, and distribution

a. The dwarf mistletoe in Chichuahua pine in Arizona was found to be an undescribed species. It is being named Arceuthobium gillii in a manuscript accepted for the fall issues of Brittonia. A. gillii differs from A. vaginatum (with which it had long been confused) in its hosts, time of flowering, time of seed dispersal, shoot color, and in some porphological characteristics. (Hawksworth, RM, and Wiens, University of Colorado).

b. Two trips to Mexico were made during 1963 to study the taxonomic relationships of Arceuthobium, particularly of those species common to the Southwestern United States, Several dwarf mistletoes not previously reported from Mexico were found, (A. campylopodum f. blumeri, A. douglasii, A. vaginatum f. crypotopodum, and A. gillii). The taxonomic status of several other dwarf mistletoes collected is now being studied. (Hawksworth, RM, and Wiens, University of Colorado).

c. Several Pinus aristata stands in Colorado were examined by dwarf mistletoe. Two species were found to parasitize this tree: A. vaginatum f. cryptopodum and A. americanum. The bristlecone pine was very susceptible to A. americanum, at least where this tree was mixed with lodgepole pine. The limber pine dwarf mistletoe, (A. campylopodum f. cyanocarpum), which frequently parasitizes bristlecone pine elsewhere in the West, has not yet been found on this tree in Colorado. (Hawksworth, RM).

d. Over 70 squashes of radicle tips from laboratory-germinated dwarf mistletoe seed (Arceuthobium douglasii, A. americanum, A. campylopodum f. laricis) were prepared for chromosomal examination. Seven staining schedules and several pretreatments were tried. Best results were obtained with aceto-iron-haematoxylin (Wittmann, 1962. Stain Tech. 37:27-30) and with pretreatment in 1.0 per cent colchicine. Spreading of chromosomes, however, was not sufficient to allow accurate counts of measurements. Seeds of A. campylopodum f. tsugensis, germinated in the field and collected in late April, exhibited a much greater number of dividing cells than those in the laboratory and will be used in future trials. (R.B. Smith, Victoria).

e. Meiotic chromosome counts have been made of the following dwarf mistletoes, all of which show a chromosome number of $n = 14$: A. americanum; A. campylopodum forms campylopodum, abietinum (white fir), cyanocarpum, blumeri, divaricatum, laricis, microcarpum, and tsugensis, and A. vaginatum f. cryptopodum. Currently attempts are being made to obtain meiotic or mitotic counts of the remaining United States and Mexican species of Arceuthobium and to construct karyotypes for them. (D. Wiens, Univ. of Colorado).

II. Physiology and Anatomy

a. Field studies on the physiology of dwarf mistletoe (Arceuthobium campylopodum form abietinum) have been continued in the Stanislaus National Forest.

The photosynthetic activity of aerial shoots of dwarf mistletoe was investigated both in the greenhouse and in the field. Greenhouse studies on detached shoots indicated that the rate of $C^{14}O_2$ fixation was about twenty times greater in light compared to darkness. In the field there was only and eight-fold increase in the light fixation by shoots left attached to their host plant. Earlier studies had demonstrated that mistletoe shoots contain both chlorophyll a and chlorophyll b. Absorption spectra of acetone extracts from mistletoe shoots showed that the pigment complex of the parasite is much like that of host leaves only at a lower concentration. In an effort to measure the rate of photosynthetic carbon fixation of mistletoe shoots, studies were conducted using an infrared gas analyzer to monitor, the CO_2 concentration in a closed chamber containing the aerial shoots. Studies conducted in the laboratory with detached shoots and in the field with shoots attached to their host plant, all failed to demonstrate any difference in CO_2 evolution in light compared with darkness. Thus while mistletoe shoots do fix CO_2 photosynthetically, the rate of this fixation is very much below the rate of respiratory CO_2 evolution. Studies are being conducted to compare the metabolic rate of carbon fixed in light with that of carbon fixed in darkness.

Attempts have been made to determine the site of carbon transfer between the host and the endophytic system of the mistletoe by means of historadioautography. Technical problems have prevented the obtaining of very clear pictures, however, this work is being continued.

A study of the chemical nature of carbon moving from the host to the parasite has been undertaken, but no reportable results are as yet available.

The influence of herbicidal treatment (2,4-D and 2,4,5-T isooctyl esters) to the aerial shoots of Phoradendron flavescens infecting blue oak has been studied in its affects on the translocation of C^{14} labeled 2,4,5-T applied to Phoradendron shoots has also been studied. Results of these tests have not as yet been analyzed.

This study on the physiology of mistletoe parasitism will be terminated at the end of this year. Publications will be forthcoming shortly thereafter. (O.A. Leonard & R.J. Hull, Botany Department, University of California, Davis).

b. Pigment determinations are being made on dwarf mistletoe seed. Column chromotography using powdered sugar is being employed. Xanthophylls have been recovered. (E.F. Wicker, IM).

III. Life cycle studies

a. Seed from several species and forms of dwarf mistletoe were collected in September and October for laboratory germination. Thirteen hundred were placed in petri dishes on moist cheese cloth (Scharpf and Parmeter, 1962. J. Forestry 60:551-552). Germination varied from over 70 per cent for A. douglasii to less than 5 per cent for A. campylopodum f. tsugensis and A. campylopodum f. laricis. Fifteen per cent germination was obtained from A. americanum seeds. Maturity of seed at time of collection was likely the most important factor contributing to the different results. Germination of A. douglasii seed reached only 12 per cent 11 weeks after plating, rose to 72 per cent by 22 weeks and then levelled off. Germinated seeds of all species were still alive nearly 7 months after collection. (R.B. Smith, Victoria).

b. Results of 1958 seeding of red firs with 100 red fir dwarf mistletoe seeds showed that, of 34 infections obtained, 20 appeared in 1960, 9 in 1961, and 5 in 1962. No new infections were found in 1963. Of 8 known females, 1 produced 3 seeds in 1962 and 6 produced abundant seeds in 1963, indicating that at least 5 years are required for the production of significant amounts of seed. Most male shoots died after flowering. Of 9 males that flowered in 1962, 4 produced no shoots in 1963 and 5 produced new flowering shoots in 1963. Of 20 infections that appeared in 1961, 4 have failed to progress beyond the bud stage. Of 20 seeds each on 1,2,3,4, and 5 year-old branch wood, the numbers of infections were 6,8,9,6, and 5 respectively, indicating no significant differences in susceptibility of 1-5 year-old segments.
(R.F. Scharpf and J.R. Parmeter, Berkeley.)

c. Studies of the effects of temperature and relative humidity on dwarf mistletoe seed (3 species) in storage indicate that temperature is a very critical factor affecting viability retention, while relative humidity has little or no effect.

Study of the effect of photoperiod on dwarf mistletoe plants indicate that they are short day plants. Flowering has been induced on A. douglasii and A. campylopodum f. laricis by decreasing the photoperiod.
(E.F. Wicker, IM).

IV. Host-Parasite Relations

a. During the course of evaluating growth losses caused by A. campylopodum f. tsugensis on western hemlock, the distribution of infections within the crown has also been noted. In trees averaging 110 feet high and 75 years old the distances infections have been found from the top varied from only 6 feet in heavily infected trees to over 40 feet in lightly infected trees. (R.B. Smith, Victoria.)

b. The host-parasite relations of systemically infected Douglas-fir and western larch are not clearly understood. Kuijt has reported the presence of the endophytic system of A. americanum in dormant buds in witches' brooms of infected lodgepole pine. Histological sections of infected Douglas-fir and western larch are being studied to determine if the endophytic system of the parasite is inhabiting dormant buds of the infected host.
(E.F. Wicker, I.M.)

V. Effects on Hosts (Damage, Mortality)

a. The study mentioned in last year's summary to determine the effects of A. vaginatum on the growth and yields in ponderosa pine was continued in Colorado, Arizona and New Mexico. More than 60 transects involving over 4,000 trees have been established to date. Field work for this study will probably be finished next summer.

Preliminary analyses from the IBM cards from 16 transects on one National Forest in Colorado has been started by Don Flora of the PNW Station to obtain information on spread, intensification, and mortality for use in his economic analysis of dwarf mistletoe control in ponderosa pine. (Hawksworth, Lightle, and Hinds,RM).

b. Dwarf mistletoe and its effect on growth and mortality in lodgepole pine stands of Alberta. Data being processed for publication. (J.A. Baranyay, Calgary)

c. The ralationships of tree growth to brooming of Douglas-fir has permitted the development of a marking guide for selective cutting in southern Oregon. (K.R. Shea, Weyerhaeuser Company).

d. Diameter increments of infected ponderosa pines are being investigated to develop improved marking guides for stands to be selectively logged. (K.R. Shea, Weyerhaeuser Company).

e. Twenty-five western hemlock, 70 to 90 years old, 90 to 130 feet high, and including a range of infection intensity, have been felled and discs taken for ring measurements. The location of all infections on the main branches of two trees were recorded. As this procedure was found too time-consuming (some 250 infections were located on a "moderately" infected tree), a sample of branches was examined on the remaining trees. Advanced decay was found associated with several stem swellings.(R.B. Smith, Victoria).

VI. Ecology - no reports.

VII. Control - chemical

a. Mistblower applications of chemicals to young Douglas fir in the field continues to give control 2 years after treatment. Spring trials have been much more effective than late-summer trials. Sprays applied by helicopter in 1962 are in the initial stages of evaluation as well as 1963 bole injection trials. The latter appear especially effective. (K.R. Shea, Weyerhaeuser Company).

b. Screening of herbicides for control of dwarf mistletoe on major timber species of pines in California continues. Concentrations of herbicide, fuel oil carriers, carrier adjuvants, and stages of host phenology are important project variables. Three tests applied in the fall of 1959 still show good results on actually sprayed infestations. Many subsequent tests show excellent direct control. Systemic effects so far have been mediocre. (C.R. Quick, Berkeley).

VIII. Control - Biological

a. Wallrothiella arceuthobii was found parasitizing Arceuthobium douglasii south of Durango, Mexico. This represents a southward extension in the range of the fungus of more than 650 miles from its previously known southern limits in Arizona and New Mexico. Two insects which are associated with dwarf mistletoes in the U.S. were found in the vicinity of Mexico City: Mitoura spinetorum (Lepidoptera) and Neoborella tumida (Miridae). Hawksworth, RM).

b. Collections of dwarf mistletoe plants infected with the hyperparasite Colletotrichum gloeosporiodes have been made from three areas in Washington during the past year. (E.F. Wicker, I.M.).

IX. Control - Silvicultural

a. Experiments initiated in 1957 have shown a marked positive effect of thinning on growth of leave trees. Latent infections have continued to develop during the 5-year period following sanitation suggesting that pruning while effective may not be an economical and practical method for control over large areas.
(K.R. Shea, Weyerhaeuser Company).

X. Surveys

a. Dwarf mistletoe infected lodgepole pine stands were air photographed in October, 1962, using Super Ansco chrome and Ansco Suprem films. The scale was 200 feet to 1 inch. We found that even large scale photography is not suitable to detect malformations.

Further work will be done In August, 1963, to test vertical and oblique photography using panchromatic, infrared, and color films at scales of 1320 feet to 1 inch, 660 feet to 1 inch, and 200 feet to 1 inch in an effort to detect the patch effect of dwarf mistletoe infected stands.
(J.A. Baranyay, Calgary).

Needed Research

I. Taxonomy, hosts, and distribution

a. Studies should be initiated to ascertain whether different forms of A. campylopodum exist on hemlock, Pacific silver fir, and lodgepole pine in coastal areas of British Columbia.
(R.B. Smith, Victoria).

III. Life Cycle

a. Studies are needed to determine the rate of development of the endophytic rate of development of the endophytic system of dwarf mistletoes on Douglas-fir and western larch as a basis for the establishment of pruning guides.
(E.F. Wicker, I.M.).

XI. Miscellaneous

a. In light of the diverse and intensive investigations which are being made on the dwarf mistletoe problem from so many fronts, Dr. Leon I. Cohen has expressed fear for the survival of the genus. He is considering a foundation of "Save the Dwarf Mistletoe League" and invites interested persons to become charter members.
(Transmitted by F.G. Hawksworth, RM).

APPENDIX VI.

Minutes of the Business Meeting

The business meeting was called to order by the Chairman, Gardiner Shaw, on Friday afternoon, September 13, 1963.

Secretary's Report:

It was moved and seconded that the minutes of the previous meeting, as reported in the Proceedings of the Tenth W.I.F.D.W.C. be approved. The motion passed by a voice vote.

Treasurer's Report:

The financial statement was given as follows:

	Debits	Credits
Registration and Banquet		$418.70
Balance from 1962		93.52
Banquet and hotel expenses	$302.69	
	302.69	512.22
Balance on hand	209.53	
	$512.22	$512.22

It was moved and seconded that the report be accepted - Motion passed.

Report of the Interim Program Chairman:

The Interim Program Chairman, Joe Baranyay, submitted a list of topics to be considered for next year's program which had been suggested by members during the week. His report is contained in Appendix I.

Report of the Mistletoe Committee:

Committee Chairman Dick Parmeter submitted the Mistletoe report, which is contained in Appendix V of these Proceedings.

Old Business:

Last year's Secretary-Treasurer presented an abject apology for transferring Victoria from B.C. to Alberta in last year's report.

A discussion was held concerning the title of W.I.F.D.W.C. In spite of some difficulties in the past it was decided that the title does not create a problem. No action was taken to change the name.

Don Leaphart requested that project statements be brought up to date before next year's meetings.

All correspondence concerning the W.I.F.D.W.C. should be turned over finally to Ray Foster, as Conference Historian.

It was moved by Willis Wagener and seconded by Bob Scharpf that a telegram be sent to Senor Inda expressing the regrets of the members that he was unable to attend the meeting because of a recent heart attack. The motion was passed unanimously.

A recommendation was made that the podium and gavel be sent to the new chairman before each meeting of W.I.F.D.W.C.

It was suggested that the program chairman be responsible for deciding whether or not to have a banquet speaker at each conference.

A motion was made and passed that the conference give a vote of thanks to Clarence Quick for the excellent chemical control report in the Tenth Proceedings.

New Business:

It was moved by Keith Shea and seconded by Phil. Thomas that W.I.F.D.W.C. hold a joint meeting with the entomology work conference within the next three years. Gordon Wallis and Fields Cobb moved to amend the motion to read that we consider holding a joint meeting. After considerable discussion both the amendment and the original motion were defeated. Dick Parmeter moved that a committee be appointed to consider holding a joint meeting with the entomology work conference. This motion was carried.

The meeting decided that the new chairman should correspond with Dick Smith (Victoria) and Ed. Wicker about preparing a report on the ecological information which is available for each region for the next meeting. This is not to be a standing committee.

Dr. Buchanan suggested that the subject of air pollution be included in the next report.

Selection of Meeting Place for 12th Conference:

Invitations were received from Great Falls, Mont., Tuscon, Arizona;

Berkeley, Calif.; and East Glacier, Montana to be considered as sites for the next meeting. On a show of hands there was a clear majority in favour of Berkeley.

Nomination of Officers:

Keith Shea and Bob Scharpf were elected as General Chairman and Secretary-Treasurer, respectively, for the 12th W.I.F.D.W.C.

A vote of thanks was extended to Lowell Farmer and the Local Arrangements Committee, and to Bob Scharpf, the Program Chairman.

The meeting was adjourned.