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**PROJECT**  
**STATEMENTS**  

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**PRAIRIES REGION**  

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**1971-72**

*1970-71*



**FOREST RESEARCH LABORATORY**  
**Canadian Forestry Service**  
**Edmonton, Alberta**

**MAY, 1971**

RESTRICTED

CANADA

DEPARTMENT OF FISHERIES AND FORESTRY

PROJECT STATEMENTS

PRAIRIES REGION

70-71  
1971-72

FOREST RESEARCH LABORATORY

Canadian Forestry Service

MAY 1971

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Armillaria mellea, stem rusts, other destructive agents in young lodgepole pine stands.
3. Investigator: H.S. Whitney & J.A. Baranyay
4. Year of Commencement: 1968.
5. Estimated Year of Completion: Original 1978.
6. Key Words not in Title: Cronartium, Peridermium, big game and rodents, SA 1, B 19.
7. Discipline: Pathology.
8. Project Group: Detection and estimation of tree pest damage.
9. Estab. Proj. No. A 067 Service Proj. No. NOR 034
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 0.25. Other: 1.
12. Man-months utilized in fiscal year under review: Prof.: 0.1. Other: 0.5.
13. Man-month requirements in next fiscal year: Prof.: 0.1. Other: 1.5.
14. Location of Work: Robb, Alberta.
15. Background Statement:
  - a - Project proposed by: Canadian Forestry Service.
  - b - Objectives:
    1. Describe the long-term variation of disease occurrence in post-fire natural lodgepole pine stands.
    2. Identify and assess the factors affecting the incidence and rate of damage caused by Armillaria mellea in post-fire natural lodgepole pine.

3. Recognition of external symptoms of A. mellea infection on lodgepole pine to assist in locating incipient attacks in young stands.

4. Record the presence and effect of other infectious and non-infectious agents in the development of lodgepole pine stands.

c - Need for project: Armillaria mellea is a widespread disease of pine regeneration in Alberta. The long-term behaviour of the disease in natural young stands is not known, nor whether site, stand conditions, or other non-infectious agents are predisposing trees to the disease.

In Alberta, fire plays a major role in the origin of lodgepole pine, Pinus contorta Dougl. var. latifolia Engelm. forests. An area of about 1,000 acres between Edson and Robb was burned in May, 1941, and has since been known as the Robb Burn. The conditions of a new stand near Robb, Alberta, as regards Armillaria, stem rusts and other damaging agents were investigated in 1953, 1957 and 1958 by Disease Survey Staff. The disease conditions that were apparent in 1957 and 1958 prompted the initiation in 1959 of a more thorough examination based on permanent plots.

d - Co-operating Agencies: None.

16. Accomplishments to beginning of fiscal year under review:

Seven 1/20-acre sample plots were established in 1959 to sample disease conditions on a wide range of sites. Plots were re-surveyed in 1962. The results of this survey were published in the Forestry Chronicle, Vol. 40, No. 3, in 1964.

The plots are re-surveyed every third year and one plot was re-surveyed each year to register internodal growth of healthy and Armillaria-infected trees.

17. Goals set for fiscal year under review:

To re-survey plot No. 7 for internodal growth.

18. Accomplishments during fiscal year under review:

Plot No. 7 was re-surveyed all data obtained until the 1967 re-survey were tabulated. Due to J. A. Baranyay's transfer to Victoria the project has to be transferred to someone in the Alberta-Territories Region. To facilitate the uninterrupted continuation of the project the

preparation of an information report is in process to summarize the results obtained during the first 9 years.

19. Goals for next fiscal year: All seven plots should be re-surveyed.
20. Signatures:

J. Baranyay (RWR) March, 1971.  
J. Baranyay,  
Investigator.

PROJECT REVIEW STATEMENTFiscal Year: 1971-1972.

1. Establishment: Edmonton, Alberta.                      Date Prepared: March, 1971.
2. Title:                                                              Physiology of reactions of roots of tree seedlings to fungal attack.
3. Investigator:                                                      D. Hocking.
4. Year of Commencement:                                              1968.
5. Estimated Year of Completion:                                      Original 1973.
6. Key Words not in Title:                                              Resistance, rhizosphere.
7. Discipline:                                                              Pathology.
8. Project Group:                                                              Reduction of losses from root diseases.
9. Establishment Project No.: A 058                                      Service Project No.: NOR 027
10. Status at time of statement preparation:                                              Suspended.
11. Estimated total man-months utilized to date:                                      Prof.: 6    Other: 12
12. Man-months utilized in fiscal year under review:                                      Prof.: 0    Other: 0
13. Man-month requirements in next fiscal year:                                      Prof.: 0    Other: 0
14. Location of Work:                                                              Edmonton.
15. Background Statement:
  - a. Project proposed by:                                              Canadian Forestry Service.
  - b. Objectives:                                                              A fundamental knowledge of host pathogen relations in the disease condition, ultimately for improved disease control.
  - c. Need for project:                                                              Fungal root diseases are a major cause of mortality among coniferous seedlings in the nursery. There has been a great deal of work on control of such diseases,

especially by chemical methods (Vaartaja, 1964). Such methods give characteristically irregular results. For progress to be made, it is desirable that greater attention be given to more basic studies.

Considerable research is underway on general ecology of soil fungi (Parkinson and Waid 1960), on ecology of soil plant pathogens (Baker & Snyder 1965), on rhizosphere fungi (Maliszewska and Moreau 1960), and on mycorrhizae (Harley, 1959; Slankis 1967). Studies of the root fungus relationships in the disease condition generally are lacking among coniferous species. A direct knowledge of the reactions of the root to attack by microorganisms could lead to a radically different approach to seedling production, especially in disease control.

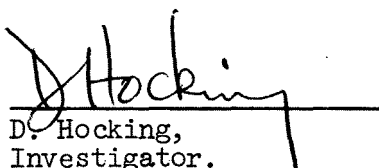
d. Co-operating Agencies: None.

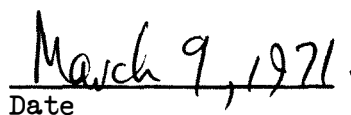
16. Accomplishments to beginning of fiscal year under review: Excised roots of lodgepole pine have been maintained in axenic culture for two years and of white spruce for one year, with transfers in defined chemical liquid medium. However, growth has been very slow. Axenic intact seedlings have been rapidly grown on defined mineral salts on perlite. Potentially pathogenic fungi have been isolated from diseased seedlings ex nursery beds. Some relationships between temperature and speed of infection have been established.

Experimental modifications of the growth medium increased growth marginally. Monoxenic cultures of lodgepole pine and Pythium intermedium were studied, but mortality of the host was too rapid for a detailed study of physiological processes involved.

Extracts of young roots were made for g.l.c. analysis for phenolic compounds, without results.

17. Goals set for fiscal year under review: Further extractions of roots for analysis, in the healthy and in the diseased state. Study of further monoxemic culture pairs.
18. Accomplishments during fiscal year under review: Analyses were made only of root growth in culture.
19. Goals for next fiscal year: Write up studies on root culture methods.
20. Signature:

  
D. Hocking,  
Investigator.

  
Date

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972

1. Establishment: Edmonton, Alberta. Date Prepared: March, 1971.
2. Title: Nursery Tree Diseases.
3. Investigator: L. W. Carlson.
4. Year of Commencement: 1966.
5. Estimated Year of Completion: A continuing project.
6. Key Words not in Title: Fungicides and disease control, damping-off, Pythium, Rhizoctonia, Fusarium, Pinus, Picea, Caragana, seedling mortality, storage and physiology, Populus, Phytotoxicity, respiration, photosynthesis.
7. Discipline: Pathology.
8. Project Group: Improved nursery production.
9. Estab. Proj. No.: MS 054 Service Project No.: NOR 062
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 44 Other: 94
12. Man-months utilized in fiscal year under review: Prof.: 8 Other: 15
13. Man-month requirements in next fiscal year: Prof.: 9 Other: 15
14. Location of Work: Forestry Research Lab, Edmonton; Forestry Research Nursery, Oakbank, Manitoba; Alberta Prov. Nursery, Oliver; PFRA Tree Nursery, Indian Head, Sask.; Sask. DNR Nurseries, Prince Albert and Big River, Sask.; Pineland Nursery, Hadashville, Manitoba; Sandilands Forest Reserve, Manitoba.
15. Background Statement:
  - a. Project proposed by: Canadian Forestry Service and on request of the provincial governments of Manitoba, Saskatchewan and Alberta.



Present project includes the following former separate projects:  
 Chemical control of nursery tree diseases (054); Effect of Fungicide  
 chemicals on tree seedling physiology (056); Miscellaneous tree nursery  
 disease problems (057).

b. Objectives: 1. To determine the more effective  
 chemical treatments for disease control, particularly conifer seedling  
 damping-off.

2. To determine the nature of  
 phytotoxicity caused by certain fungicides and to determine whether or  
 not "safe" fungicides are detrimental to the physiology of tree seedlings.

3. To investigate new nursery  
 tree disease problems and to determine their relative importance to  
 nursery tree production.

c. Need for project: Successful afforestation programs  
 for wood fibre, recreation, or aesthetic purposes depend on the supply of  
 high quality nursery stock, whether they be container seedlings or nursery  
 transplants. Nursery tree diseases account for much of the loss in quality.  
 Damping-off in some conifer seedbeds is as high as 80%, but generally  
 averages 30-35%. Although some standardization of disease control practices  
 has resulted from studies by previous workers, new chemicals showing  
 promise for better control need continuous evaluation. Evaluation of new  
 and "old" chemicals has to be done in several phases. First the chemical  
 has to prove its effectiveness in controlling the disease organism.  
 Secondly its phytotoxic activity must be shown. Knowing the phytotoxic  
 activity of a fungicide is as important as knowing its fungitoxicity if  
 we are to obtain its most efficient use. Disease control is not restricted  
 to the use of fungicides, but can be and is related to nursery cultural  
 practices. To understand the relationship of seedling diseases to cultural  
 practices the entire nursery system has to be studied. Despite apparent  
 advances in nursery techniques, seedling production is still an art and  
 not a science.

Results obtained from work in  
 this project area will hopefully lead to a reduction in disease losses  
 and an improvement of the nursery production techniques. At the present  
 time it costs about 3 cents to produce a seedling of plantable size.  
 The average annual production in the Prairies Region forest nurseries is  
 approximately 8 million seedlings with nursery operational costs of about  
 240,000 dollars. Recently (1969) losses in jackpine outplantings in  
 Manitoba were over 45% or 1 million seedlings. There is strong evidence  
 that mortality was related to problems in the nursery system and they  
 appear to be both cultural and pathological. Solving these problems and  
 others like them could possibly prevent similar losses in the future.

d. Co-operating Agencies: 1. PFRA Tree Nursery (Dept.  
 of Regional Econ. Expan.) - Planning and execution.

2. Saskatchewan DNR - Planning and execution.

3. Manitoba Department of Mines and Natural Resources - Planning and execution.

4. Alberta Dept. of Agriculture - Planning.

5. Alberta Dept. of Lands and Forests, - Planning and execution.

16. Accomplishments to beginning of fiscal year under review:

a. Objective #1.

1. Laboratory bioassays for fungitoxicity of seed treatment chemicals against isolates of Pythium spp., Rhizoctonia spp. and Fusarium spp. (causal agents of damping-off) have been run on 158 seed treatment chemicals. Of these, 142 have exhibited a high degree of activity either against all three pathogens or against one or another of them. Laboratory seed germination tests for phytotoxicity have shown that jack pine, lodgepole pine and white spruce react differentially to many of the chemicals. Greenhouse damping-off control tests have included 59 chemicals on jack pine, 41 on lodgepole pine and 34 on white spruce.

2. Soil treatment tests at the Pineland Nursery suggested that conifer damping-off was less in Mylone treated plots than in check plots with non-treated seed. Soil treatment experiments on Colorado spruce seedbeds at the PFRA nursery suggest that both Mylone and Vapam can be used to reduce damping-off.

3. Seed treatment experiments at the Pineland Nursery did not show any control of conifer damping-off with Captan and Arasan, nor with 4 experimental chemicals. Results of co-operative seed treatment trials on lodgepole pine and white spruce at the Oliver nursery (Alberta coop. trials) showed no significant damping-off control.

4. Pre-storage treatment of Gelrica poplar cuttings for control of storage breakdown (cause unknown) with Captan and Daconil dips enhances survival in the following growing season.

b. Objective #2.

1. Progress has been slow because of equipment failure and the lack of competent equipment repairment in this area. Studies were initiated on the effect of four seed treatment chemicals on the chlorophyll content of jack pine, lodgepole pine and white spruce seedlings.

c. Objective #3. 1. Isolations from diseased caragana seedlings at the PFRA Tree Nursery were made several times and Rhizoctonia spp. were recovered in early isolations and Fusarium spp. in later isolations. Both species were shown to be pathogenic on caragana.

2. Poplar cutting storage and respiration studies were further analyzed and indicated interactions between storage temperature, clone, and size of cutting. Small cuttings at low temperatures were less likely to survive in the field.

3. Western gall rust (Peridermium harknessii Moore) was found on jack pine seedlings at the Pineland Nursery.

17. Goals set for fiscal year under review:

1. To continue laboratory, greenhouse and field evaluation of seed treatment chemicals.

2. To initiate chemical control studies of a wilting disease of caragana.

3. To study rates of photosynthesis and respiration of different conifer seedlings to find the most useful species for chemical treatment studies.

4. To continue investigations into the cause of wilting of caragana, ash and lilac seedlings and to study the extent of losses caused by this disease.

5. To continue for one year investigation on the effect of different storage conditions on poplar cutting.

6. To study the development of conifer seedling damping-off in relation to seedling age and nutrition.

18. Accomplishments during fiscal year under review:

1. Laboratory bioassays for fungitoxicity of seed treatment chemicals against isolates of the three major pathogens were run on 68 seed treatment chemicals. Of these 31 exhibited a high degree of activity against all three pathogens. Forty-three were active against Pythium spp., 42 against Rhizoctonia spp. and 48 against Fusarium spp. As in previous years seed germination tests for phytotoxicity, jack pine, lodgepole pine and white spruce reacted differentially to many of the chemicals. Greenhouse damping-off control tests on all three conifer species have included 111 chemicals since the beginning of the project, of which 63 have been selected for further testing under field conditions.

2. Seed treatment experiments gave varying results this year. The Oliver nursery experiments failed because of rodent problems. At Prince Albert 7 chemicals gave significant control of jack pine damping-off; at Pineland and Big River no significant control of either jack pine or white spruce damping-off was obtained. Caragana seed treatments at the PFRA nursery gave no significant control of wilting. However some caragana seed treatments did enhance germination.

3. Soil and seed treatment tests indicate that Mylone soil treatment plus Captan seed treatment reduces damping-off when compared with Mylone soil treatment alone. Soil treatments with slow release pellets did not appreciably reduce caragana seed rot or wilting. Soil treatments with slow release pellets on conifer seedbeds failed because the pellets at the surface fused and blocked seed germination.

4. The program on conifer respiration and photosynthesis suffered a setback due to the lack of technical help for the first three months of the year. At this point a selection of species to be used has not been made because of the differential response of conifer seedlings to some of the fungicides. Vitavax, a seed treatment fungicide, has been shown to inhibit photosynthesis of jack pine seedlings. The seedlings however recover and normal photosynthesis is obtained several days after treatment.

5. After many isolations from wilting caragana seedlings grown on nursery soil in the greenhouse it is concluded that a Rhizoctonia spp. is the causal organisms in wilt of caragana. Control studies initiated during the past year were not successful because the disease was not a problem at the nursery. The extent of losses could not be obtained.

6. Respiration of poplar cuttings stored under varying conditions was affected by temperature of storage and again interactions between storage temperature, clone, size of cutting and length of storage were evident. Significant differences in respiration were noted between clones, between temperatures, and between size of cutting.

7. Isolations made from greenhouse grown jack pine seedlings and nursery seedlings indicate that there is a succession of fungi that caused damping-off. The first to attack in the spring is a Pythium sp., secondly Rhizoctonia spp. and later in the season the seedlings are attacked by Fusarium spp.

8. Mortality of first year outplantings of jack pine nursery stock was investigated. From the data collected the causes of the mortality are thought to be the use of 3-0 jack pine seedlings with a very poor shoot-root ratio and the poor storage ability of these seedlings.

## Reports and Publications:

- Carlson, L.W. 1969. Western Gall rust on jack pine nursery stock in Manitoba. Plant Dis. Repr. 53:100.
- Carlson, L.W. and J. Belcher 1969. Seed and soil treatments for control of conifer seedling damping-off. Canada Dept. of Fisheries and Forestry Bi-Monthly Res. Notes. 25 (1): 4-5.
- Carlson, L.W. and J. Belcher. 1969. Jack pine and red pine damping-off. p. 109. In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1968. American Phytopathological Society.
- Carlson, L.W. and C. Lindquist. 1969. Poplar hybrid, storage breakdown, unknown cause. p. 93. In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1968. A.P.S.
- Morgan, G.A., J.W. Hamm, and L.W. Carlson. 1969. Colorado spruce damping-off. p. 94-95. In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1968. A.P.S.
- Carlson, L.W. and J. Belcher. 1969. Seed treatment fungicides for control of conifer damping-off; Laboratory and greenhouse tests, 1967-1968. Can. Plant Dis. Surv. 49: 38-42.
- Carlson, L.W. and J. Belcher. 1970. Jack pine and white spruce damping-off; soil treatments. p. 118. In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1969. A.P.S.
- Carlson, L.W. and J. Belcher. 1970. Jack pine and white spruce damping-off; seed treatment. p. 118. In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1969. A.P.S.
- Carlson, L.W. and J.W. Hamm. 1970. Caragana seedling blight and seed rot. p. 108. In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1969. A.P.S.
- Carlson, L.W. 1970. Mortality in 1969 spring-planted jack pine plantations in Manitoba. Can. For. Serv. Confidential Report. 25 p.
- Carlson, L.W. and J. Belcher. 1970. Effect of ultrasonic root cleaning on subsequent growth of caragana seedlings Dept. Fish. Forest., Bi-M. Res. Notes 26 (3): 27.
- Carlson, L.W. and J. Belcher. 1970. Effect of nursery soil and soil amendment extracts on growth of damping-off fungi and conifer seed germination. Dep. Fish. Forest. Bi-M. Res. Notes 26 (3): 26.

Carlson, L.W. 1970. Differential phytotoxicity complicates selection of conifer seed-treatment chemicals. Dep. Fish. Forest. Bi-M. Res. Notes 26 (4): 37-38.

Carlson, L.W. and J. Belcher. 1971. Lodgepole pine damping-off. p. \_\_\_\_ In K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1970. A.P.S. (In Press)

Carlson, L.W. and J. Belcher. 1971. Jack pine damping-off. p. \_\_\_\_ In K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1970. A.P.S. (In Press).

Carlson, L.W. and R. Esan. 1971. Caragana seedling blight and seed rot. p. \_\_\_\_ In, K.D. Hickey (Ed), Fungicide-Nematocide Tests, Results of 1970. A.P.S. (In Press)

19. Goals for next fiscal year:
1. To continue laboratory, greenhouse and field evaluation of fungicides for control of conifer damping-off.
  2. To continue chemical control studies of caragana wilting and seed rot.
  3. To study rates of photosynthesis and respiration of different conifer seedlings to find the most useful species for chemical treatment studies.
  4. To study the effect of different types of storage and packing conditions on the survival of 3-0 jack pine and white spruce seedlings.
  5. To study the effectiveness of several fungicides in controlling septoria leaf spot and canker in nursery cutting beds.
  6. To monitor the conifer seedling production system at the Oliver nursery.

Planned reports and publications:

Carlson, L.W. and J. Belcher. 19\_\_\_. Seasonal development of conifer damping-off.

Carlson, L.W. and J. Belcher. 19\_\_\_. Seed-treatment fungicides for control of conifer damping-off; Laboratory and greenhouse tests, 1968-69. Can. Plant Dis. Surv. IN PRESS.

Carlson, L.W., et al. Reports to Fungicide-Nematocide Tests, Results of 1971. (On seed and soil treatments for control of nursery tree diseases.)

20. Signature:

*Lester W. Carlson*  
L.W. Carlson,  
Investigator.

March, 1971.

DETECTION AND APPRAISAL OF FOREST TREE PEST DAMAGE

Insects and diseases in outbreak abundance cause losses in wood fibre, reduction in values of recreational lands, shelterbelts, ornamental trees, and cause increase in the hazard to natural stands from fire. The Forest Insect and Disease Survey detect, identify and assess their impact. During the past several years there has been a great increase in the numbers of special surveys and appraisals carried out by the Forest Insect and Disease Survey on problems where wood fibre and/or environmental values are high. Because of the increased attention being directed toward the needs of the environment, the Forest Insect and Disease Survey have increased their activities in that particular field and include in their assessment other factors in addition to insects and diseases.

Additional studies aimed at increasing the effectiveness of the Forest Insect and Disease Survey are carried out. These involve taxonomic studies, studies to improve methods of assessment, and analysis of historical records gathered over the years by this group.

An important function of the forest insect and disease survey is to maintain and upgrade the insect and disease collections, regional and national, in the museums and generally maintain a monitoring service of the insect and disease species in the region. These data contribute to a national program and are utilized by many other agencies and institutions.

Essential to meeting the objectives of the Forest Insect and Disease Survey is an extensive liaison role with the public and with management agencies. This role constitutes a major activity of the Forest Insect and Disease Survey and is a continuing function.



PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

- |                                                      |                          |                                                                                                                            |                  |
|------------------------------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------|
| 1. Establishment:                                    | Prairies Region          | Date Prepared:                                                                                                             | March, 1971      |
| 2. Title:                                            |                          | Biotaxonomy of forest fungi                                                                                                |                  |
| 3. Investigator:                                     |                          | Y. Hiratsuka.                                                                                                              |                  |
| 4. Year of Commencement:                             |                          | 1966                                                                                                                       |                  |
| 5. Estimated Year of Completion:                     |                          | Indefinite.                                                                                                                | Revision I: 1971 |
| 6. Key Words not in Title:                           |                          | Mycology, herbarium, fungus serology, tree diseases, immunofluorescent method.                                             |                  |
| 7. Discipline:                                       |                          | Forest insect and disease survey.                                                                                          |                  |
| 8. Project Group:                                    |                          | Detection and estimation of tree pest damage.                                                                              |                  |
| 9. Estab. Proj. No.                                  | A 065                    | Service Project No.                                                                                                        | NOR 032          |
| 10. Status at time of statement preparation:         |                          | Active                                                                                                                     |                  |
| 11. Estimated total man-months utilized to date:     |                          | Prof.:                                                                                                                     | 10. Other: 60    |
| 12. Man-months utilized in fiscal year under review: |                          | Prof.:                                                                                                                     | 2. Other: 13     |
| 13. Man-month requirements in next fiscal year:      |                          | Prof.:                                                                                                                     | nil Other: nil   |
| 14. Location of Work:                                |                          | Edmonton (laboratory, Mycological Herbarium, Prairie Region (field).                                                       |                  |
| 15. Background Statement:                            |                          |                                                                                                                            |                  |
|                                                      | a - Project proposed by: | Canadian Forestry Service                                                                                                  |                  |
|                                                      | b - Objectives:          | To study the taxonomy, morphology and life history of unknown and incompletely known groups of forest fungi in the region. |                  |

c - Need for project: Our knowledge of forest fungi of the region is inadequate. The taxonomy and life histories of many important fungus pathogens of forest trees in this region are poorly known. It is essential for the forest pathological investigations and survey activities of the region to secure accurate identification and to know life histories of the pathogens involved.

d - Co-operating Agencies: Mycological Herbarium, Plant Research Institute, Ottawa.

16. Accomplishments to beginning of fiscal year under review:  
 1. Mycological Herbarium (CFB) had been developed to have about 9,000 specimens mainly of forest tree pathogens.

2. Significant results were obtained on immuno-fluorescent method of identifying fungi.

17. Goals set for fiscal year under review:

a.. Continue study of immuno-fluorescent technique for the study of forest fungi.

b. Check list of conifer tree diseases of Alberta.

18. Accomplishments during fiscal year under review:

1. Considerable progress has been made on the development of immunofluorescent technique.

2. A new pine needle fungus was discovered and described in a publication.

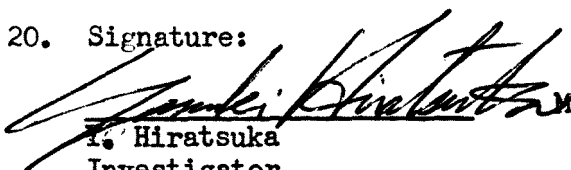
3. Two regional herbaria (Winnipeg and Calgary) are combined and reestablished in Edmonton.

Publication:

Parmelee, J.A. and Y. Hiratsuka. 1970. Phaeoseptoria contortae sp. nov. on Pinus contorta. Can. J. Bot. 48, 1002-1004.

19. Goals for next fiscal year: This project is terminated and activities in the project will be included in 033 (Forest Insect and Disease Survey).

20. Signature:

 March, 1971  
 Y. Hiratsuka  
 Investigator

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Forest Insect and Disease Survey.
3. Investigators: W.G.H. Ives, R.A. Blauel, Y. Hiratsuka and H.R. Wong.
4. Year of Commencement: 1941.
5. Estimated Year of Completion: Original: a continuing project.
6. Key Words not in Title: Detection, appraisal, distribution, parasites, hosts.
7. Discipline: Forest Insect and Disease Survey.
8. Project Group: Detection and estimation of tree pest damage.
9. Estab. Proj. No.: A 066 Serv. Proj. No.: NOR 033
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: Other:
12. Man-months utilized in fiscal year under review: Prof.: 20 Other: 72
13. Man-month requirements in next fiscal year: Prof.: 20 Other: 72
14. Location of Work: Manitoba, Alberta and Saskatchewan, National Parks, Yukon Territory Mackenzie District of N.W.T.
15. Background Statement:
  - a. Project proposed by: Canadian Forestry Service.
  - b. Objectives: To gain an improved knowledge of forest insects and diseases in the region for the purpose of minimizing damage to the forest attributable to these organisms and to provide an advisory service to management agencies and the public.

c. Need for project: Forest insects and diseases annually destroy and/or degrade large quantities of otherwise useable wood fibre. They cause important damage to nursery plantation and park plantings which have high aesthetic or shelter values. Many complex problems confronting resource managers have their origin in insect or disease activities. In other instances, these organisms may appear to be primary causes of damage when in fact they are symptoms of the effects of other factors. It is essential for amelioration of the problem that diagnosis be correct. When diagnoses have been completed it is often necessary that some measure of impact, in quantitative terms, be obtained. For these reasons the Forest Insect and Disease Survey is maintained as a large group and staffed by specialists. The relations between insects, diseases and their hosts are complex, most often obscure, and require highly trained personnel to make correct assessments. The biological data collected by the Survey and systematically analyzed and stored provide essential information on life cycles, natural control agents, and geographic distributions to research entomologists, pathologists and other biologists. Many of these species are widely distributed across Canada, and the regional data are part of a larger body of data collected by this and other regions. Outside agencies such as universities and Provincial governments, utilize data collected by the Forest Insect and Disease Survey. Improved insight into phenomena responsible for fluctuating insect, disease plant and animal populations are attributed to contributions by this group.

d. Co-operating Agencies: Alberta Department of Lands and Forests, Manitoba Department of Mines and Natural Resources, Saskatchewan Department of Natural Resources, Alberta Department of Agriculture, Manitoba Department of Agriculture, Saskatchewan Department of Agriculture, Entomology Research Institute, Biometrics and Computer Science Branch, Yukon and Mackenzie District Forest Services, National Parks Branch.

16. Accomplishments to beginning of fiscal year under review:

Infestations of all of the major forest insects of the region have been assessed since the inception of the Survey and more recently a large amount of information on diseases of the region has also been obtained. Life cycles and other biological data have been accumulated for all the major insects and diseases within the region and where circumstances required, intensive studies were carried out on specific organisms. Numerous impact and appraisal surveys have been carried out in response to special needs.

This project is now an amalgamation of M8066, A064.

17. Goals set for fiscal year under review:

1. The detection and appraisal of problems associated with insects and diseases in forested areas of the region, including National, Provincial and Municipal parks.

2. Increased attention to high-value planted trees in roadside parks and farm shelterbelts.

3. The regional insect and disease reference collections will be kept up to date and expanded where necessary.

18. Accomplishments during fiscal year under review:

Detection and appraisal surveys were carried out in the areas of commercial forest, national, provincial, and urban parks, and shelterbelts. Particular attention was given to planted trees and campsites so that any problems could be detected at an early stage. Most of the shelterbelts examined were well cared for and had very few problems. Cultural practices in some plantings should be modified to reduce damage to the trees. Trees in some campsites showed adverse effects attributed to over-use and inadequate protection. Considerable time was spent on liaison and extension work.

There were no major insect outbreaks or large increases of disease incidences in the Prairie Region in 1970. However, notable levels of both insects and diseases did occur in some of the Region's high-use areas. Spruce budworm populations continued to decline, except in the Interlake area and in Sprucewoods Provincial Forest. The forest tent caterpillar outbreak in Alberta continued, in much the same area as in 1969. The large aspen tortrix outbreak increased in Manitoba, while infestations in Alberta declined and those in the Yukon collapsed. Larch sawfly infestations were confined primarily to southeastern Manitoba, with patches elsewhere in Manitoba and east-central Saskatchewan. The recently introduced parasite of the larch sawfly, Olesicampe benefactor, maintained high levels of parasitism, and is now becoming widely distributed in the general release area. Very little new infestation by the spruce beetle was recorded in either the Crowsnest Forest or Banff National Park infestations. The Bruce spanworm caused considerable defoliation in Alberta, and the small infestation of the jack-pine budworm in the Sandilands Provincial Forest increased in size and intensity in 1970.

Leaf and twig blight of poplar was prevalent throughout the region, especially on regeneration. Several leaf rusts, including two conifer needle rusts, were common, but damage was generally light. Leaf spots on balsam poplar and trembling aspen were also fairly common. Pine stem rusts were widely distributed, although damage was generally light.

Progress has been made in consolidation of insect and disease collections from the former Saskatchewan-Manitoba and Alberta-Northwest Territories regions.

Spruce bark beetle damage appraisal surveys were completed. The incidence of spruce beetle attacks in 1971 is expected to be about the same as that in 1970 with perhaps a slight increase in the South Castle and Bunny Creek stands. Incidence of attack in 1970

was about one-third of that in 1969. In the 12 stands examined, the average percentage of volume successfully attacked in 1970 was 1% and the largest percentage of volume attacked (South Castle River) was 2.75%. Although beetle activity in the outbreak areas declined during the past two years, current population levels still constitute a potential hazard to the residual and uninfested mature spruce stands in southwestern Alberta. A continuance of salvage operations to remove infested trees is recommended. In our view, prompt salvage-logging to date has resulted in significant saving of lumber that would otherwise have been killed by the beetles. Management agencies are utilizing data from these appraisal surveys. Reports were submitted.

Spruce budworm damage appraisal surveys were carried out in the commercial forests of northern Alberta, Wood Buffalo National Park, Mackenzie District, N.W.T. Populations were down from preceding years and except for small localized infestations are predicted to remain low in 1971. Damaged stands resulting from many years of budworm attack were identified. Management agencies were advised of the conditions of those stands, estimates of tree mortality and die-back to date and likely consequence of future budworm attacks. Reports were submitted.

An insect and disease hazard rating for Waterton Lake National Park was undertaken. Approximately 40 man-days were spent making ground surveys in the park. This information is being used in conjunction with Forest Insect and Disease Survey records and detailed forest cover maps to devise a hazard rating for stability. The work is of an exploratory nature, and is still underway. Considerable progress has been made towards developing meaningful hazard rating that should be applicable to other parks, with revisions where necessary.

Two intensive surveys were undertaken on Atropellis canker disease of pine in Alberta. They showed that the distribution of Atropellis was limited to the Cypress Hills area and the western portion of Alberta along the rocky mountain foothills region south of latitude 56. Host specificity was found not to be a limiting factor in the spread of the disease.

Field trials were designed and implemented to evaluate the effectiveness of using clear-cut buffer zones as method to contain the spread of the disease, and allow accurate determination of the age at which pine became susceptible to infection.

The Forest Insect and Disease Survey continued to act in response to numerous requests for special assessments of insect and disease problems in parks, nurseries, shelterbelts, farmsteads, and private homes. These requests were generally satisfied by inspections by staff members, by verbal comments to or by correspondence.

## Publications:

Ives, W.G.H., R.A. Blauel, and J.K. Robins. 1971. Important Forest Insect and Diseases, Prairies Region. In Annual Report of the Forest Insect and Disease Survey, 1970. Can. For. Serv., Dept. of Fisheries and Forestry, Ottawa. (In Press).

## Reports:

Robins, J.K. et al. 1971. Annual District Reports, Forest Insect and Disease Survey Prairies Region, 1971. Forest Research Laboratory, Edmonton. File Report.

Stevenson, R.E. The spruce budworm in Northern Alberta with emphasis on the Wabasca outbreak. Int. Rept. A 28 March, 1970.

Safranyik, L. and J. Petty, 1971. 1970 Spruce Beetle Survey of the Crowsnest Forest, Alberta. For. Res. Lab., Edmonton. Int. Rpt. A-41.

Cerezke, H.F. 1970. Spruce budworm conditions in northern Alberta and Northwest Territories. File Rept.

Blauel, R.A. 1970. The survival of container seedlings planted at Mercond, Alberta. File Rept.

Blauel, R.A. and R.C. Tidsbury. 1970. The 1970 Thompson Smoke Easement. File Rept.

## 19. Goals for next fiscal year:

1. The detection and appraisal of insect and disease outbreaks in forested areas will continue, augmented by aerial surveys where warranted. Particular attention will be given to the accessible forested areas presently under utilization.'

2. Appraisals relating to stand stability will be conducted in National and Provincial Parks.

3. Spruce budworms and spruce beetle damage appraisal surveys will be carried out.

4. A study will be carried out in co-operation with the Alberta Forest Service to determine decay degradation rates, strength reduction factors and fastening device retention qualities of *Atropellis* cankered pine stock that may be utilized in the commercial pest and pole industry.

5. The hazard rating for Waterton National Park will be completed and a similar rating prepared for Prince Albert National Park.

6. Surveys will be conducted to detect gross damage to the forest community resulting from atmospheric effluents associated with oil and gas production.

7. Maintenance and improvements of regional insect and disease identifications, biologies and reference collections will be carried out.

8. Editing of historical data on insects will be completed.

Anticipated Reports and Publications:

Ives, W.G.H., R.A. Blauel and J.K. Robins. Annual report of the Forest Insect and Disease Survey, Prairie Region, 1971.

Petty, J. et al. Annual District Ranger Reports, Forest Insect and Disease Survey, Prairie Region, 1971.

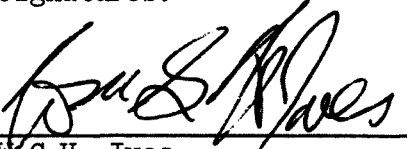
Safranyik, L. et al. Spruce beetle in the Crowsnest forest, 1971.

Cerezke, H.F. et al. Spruce budworm in northern Alberta and the Northwest Territories, 1971.

Blauel, R.A. and J.C. Hopkins. The distribution of Atropellis canker disease of pine in Alberta, 1971.

Blauel, R.A. Hypoxylon canker disease on aspen in Alberta, 1971.

20. Signatures:



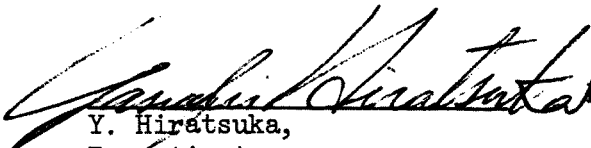
March, 1971.

W.G.H. Ives,  
Investigator.



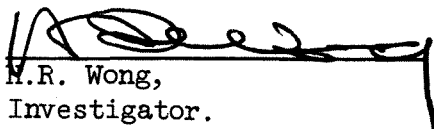
March, 1971.

R.A. Blauel,  
Investigator.



March, 1971.

Y. Hiratsuka,  
Investigator.



March, 1971.

H.R. Wong,  
Investigator.



PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972

1. Establishment: Edmonton, Alberta. Date prepared: March, 1971.
2. Title: Identification and life history studies of miscellaneous forest insects in the Prairies Region.
3. Investigator: H. R. Wong.
4. Year of Commencement: 1948.
5. Estimated Year of Completion: Original - a continuing project.
6. Key Words not in Title: Galls, damage, distribution, hosts, parasites, seasonal occurrence.
7. Discipline: Forest Insect and Disease Survey.
8. Project Group: Forest Insect and Disease Survey.
9. Estab. Proj. No.: MS 037 Service Project No.: NOR 057
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 42 Other: 64
12. Man-month utilized in fiscal year under review: Prof.: 2 Other: 5
13. Man-month requirements in next fiscal year: Prof.: 3 Other: 6
14. Location of work: Edmonton.
15. Background Statement:
  - a. Project proposed by: Canadian Forestry Service.
  - b. Objectives: To determine the species, life history, distribution, damage, hosts and parasites of the more common forest insects in the Prairies Region.
  - c. Need for project: The efficiency of the Forest Insect Survey in the Canadian Prairies is dependent upon the ability to recognize all stages and damage of the more common forest insects, new

or relatively unknown species that are capable of causing appreciable damage, and those species observed to be on the increase in this area. Accordingly studies are initiated as the opportunities arise to identify and determine the life history, parasites, hosts and distribution of these species. The information obtained would aid in determining the abundance of these species, methods of control either by chemical or biological means, and the best time to apply these controls.

d. Co-operating agencies: Material and information are supplied by the Insect Taxonomy Section, Canada Department of Agriculture, Ottawa, personnel of the Forest Insect and Disease Survey across Canada, and entomologist in Canada and the United States.

16. Accomplishments to beginning of fiscal year under review:

The identification and description of the complex of insects in the tops of black spruce have been made, together with a diagnostic key to separate them and the type of feeding damage caused by each species. The study showed no indication that insects caused the club-top condition on black spruce.

Field keys and description have been published on how to separate the adult June beetles attacking coniferous plantations in Manitoba, and galls of Saperda, Xyelid and Eurytoma.

The results of studies on the distribution, parasites and life history of the following insects in Manitoba and Saskatchewan have been published: Saperda prob. calcarata attacking root collars of poplar, Zeugophora scutellars, Agrilus criddlei, Herculia thymetusalis, Pseudexentera oregonana, Eucosma gloriola, Rhyacionia frustrana and Eurytoma calycis.

The life history and importance of the syrphid predator Phalacrodira nioritarsis in controlling Chrysomela crotchi have been published. Likewise the study on the distribution of the elm bark beetle, Hylurgopinus rufipes in Manitoba and Saskatchewan.

17. Goals set for fiscal year under review:

1. Identify additional galls of insects and take photographs of them.

2. Prepare a report on the fauna of Dibotryon morbosum.

3. Determine the forest lepidopterous species present in Manitoba and Saskatchewan that are not recorded in the four volumes of the Forest Lepidoptera of Canada, and

obtain for these species information on distribution, known host, seasonal occurrence, feeding habit and prevalence.

4. Collaborate with Drs. DeBoo and Sippell on a paper entitled: "The eastern pine-shoot borer, Eucosma gloriola Heinrich (Lepidoptera: Tortricidae) in North America".

5. Determine larval activity of Dioryctria banksiella in galls of Endocronartium harknessii and Cronartium comandrae of Pinus banksiana.

18. Accomplishments during fiscal year under review:

1. Report - Wong, H.R., B.B. McLeod and J.C.E. Melvin. 1970. Some of the common galls and abnormal plant growths caused by insects and mites in the forested areas of Manitoba and Saskatchewan. Forest Research Laboratory, Winnipeg, Manitoba. Information Report MS-X-23. 55 pp.

2. Publication - Melvin, J.C.E. and H.R. Wong. 1969. The arthropod fauna of Dibotryon morbosum (Schw.) Theiss. and Syd. (Ascomycetes: Dothideaceae) in Manitoba and Saskatchewan. Manitoba Ent. 3: 58-64.

3. Report - Wong, H.R. and J.C.E. Melvin. 1970. Additions to the Forest Lepidoptera of Manitoba and Saskatchewan. Forest Research Laboratory, Winnipeg, Manitoba. Information Report MS-X-26. 45 pp.

4. Submitted for publication in Can. Ent. DeBoo, R.F., W.L. Sippell and H.R. Wong. The eastern pine-shoot borer, Eucosma gloriola (Lepidoptera: Tortricidae), in North America.

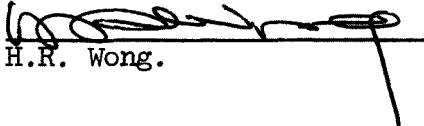
5. The seasonal occurrence, parasites and larval habits of Dioryctria banksiella in the western gall rust Endocronartium harknessii have been determined. Morphological characters have been found to separate the larvae and pupae of D. banksiella from its closely related species.

Other reports:

Melvin, J.C.E., H.R. Wong and B.B. McLeod. 1970. Insect parasites of some insect galls in the forested areas of Manitoba and Saskatchewan. Forest Research Laboratory, Winnipeg, Manitoba. Information Report MS-X-25. 12 pp.

Melvin, J.C.E., D.W. Murray, J. Harding and H.R. Wong. 1970. The insect collection of the Forest Insect and Disease Survey in Manitoba and Saskatchewan. Part II. Coleoptera. Forest Research Laboratory, Winnipeg Manitoba, Information Report MS-X-27, 27 pp.

19. Goals for next fiscal year:
1. Record the distribution, host and seasonal occurrence of the five coniferous budworm in Alberta.
  2. Prepare a paper on Dioryctria banksiella in the western gall rust Endocronartium harknessii.
  3. Determine if spumulin covering egg bands of Malacosona californicum lutescens affect rate of parasitism. This project was initiated by N.R. Brandt, Winnipeg, Manitoba.
20. Signature:

  
H.R. Wong.

March, 1971.

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972.

1. Establishment: Edmonton, Alberta. Date Prepared: March, 1971.
2. Title: Sawfly systematics.
3. Investigator: H. R. Wong.
4. Year of Commencement: 1950.
5. Estimated Year of Completion: Original - a continuing project.
6. Key Words not in Title: Tenthredinoidea, Nearctic Region, Distribution, Hosts, Keys, Life History, Morphology, New Genera, New species, Biogeography, Revision, Symphyta, Evolution, Phylogeny.
7. Discipline: Forest Insect and Disease Survey.
8. Project Group: Forest Insect and Disease Survey.
9. Estab. Proj. No.: MS 039 Service Project No.: NOR 058
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.; 76 Other: 18
12. Man-month utilized in fiscal year under review: Prof.: .50 Other: 0
13. Man-month requirements in next fiscal year: Prof.: 3 Other: 6
14. Location of work: Edmonton and Ottawa.
15. Background Statement:
  - a. Project proposed by: Advisory Committee.
  - b. Objectives:
    1. To make systematic studies of the sawflies of Canada, noting their mature and immature forms, distribution, host, seasonal occurrence, importance to forestry, subspecies, strains and phylogenetic relationships.

2. To separate the various sawfly species by means of keys, descriptions and illustrations.

3. To study the evolution and biogeography of the more important sawfly genera.

4. To study the external and internal morphology of the more economic sawfly species attacking forest trees in Canada.

c. Need for project: Since insects cannot be discussed or treated in a scientific way until they have been identified, the most fundamental branch of entomology is systematics. Taxonomic relationships must be determined, so that species which are economically important can be identified and their possible areas of spread determined. Systematic studies can provide the means of making predictions and generalizations about probable habits, distribution, future importance of newly discovered species, and clues on the possible means of control. Accurate identification is also essential in restricting the spread of pest species, which can cost millions of dollars. Systematics is the means by which an orderly system is provided for storing information about organisms and is an important information retrieval device.

In the field of sawfly systematics, I am the only one actively engaged in this type of research at the present time in Canada.

d. Co-operating Agencies: The material is made available by the following agencies, and I make the identifications and supply any pertinent information if requested relating to these determinations: Insect Taxonomy Section, Canada Dept. of Agriculture, Ottawa. Insect Identification and Parasite Introduction Research Branch, U.S. Dept. of Agriculture; Washington; British Museum (Natural History), London; and various entomological departments and laboratories across Canada, United States, Europe and Asia. The Biometrics Research Service, Canada Dept. of Fisheries and Forestry co-operate by determining feasibility of separating the different strains of the larch sawfly by statistical methods.

16. Accomplishments to beginning of fiscal year under review: The value of cocoons in determining families and genera of sawflies has been published. Sawfly larvae of the subfamily Nematinae attacking conifers in the Canadian Prairie have been identified.

The Nearctic species of Pristiphora have been studied and several species placed in synonymy or in other sawfly genera, other species were found to be Holarctic in distribution and not restricted to North America or Eurasia. A phylogenetic study has been made of Pristiphora in an effort to obtain an understanding of the relationship of the species and the circumstances under which they evolved.

Descriptions have been published on the external morphology of the male, female and ultimate larval instar of the larch sawfly; and the intersexes and gynandromorphs of this insect.

The sawfly genus Decanematus was discovered to be new to North America and the genus Micronematus in North America was found to be a synonym of the European genus Eitelius.

New species were described in the following genera: Pristiphora (Brazil, Canada and U.S.A.), Allantus (Canada and U.S.A.), Decanematus (Canada), Pristola (Canada) and Metastola (Canada and U.S.A.).

Larval descriptions have been published on species in the following sawfly genera: Anoplonyx, Platycampus, Tenthredo, Nematus, Pikonema, Nematinus, Dimorphopteryx, Arge, Croesus, Cimbex, Trichiosoma, Empria and Priophorus.

Diagnostic keys to species in the following genera have been published: Pristiphora (South American adults), Eitelius (North American and European adults), Allantus (North American adults with black hind tibiae) Decanematus (North American, Japanese and European adults), Pristola (North American adults), Melastola (North American adults) and Sharliphora (Eurasian adults).

Diagnostic keys to genera of the tribe Pristolini have been published, and the new genera Sharliphora and Melastula were established.

17. Goals set for fiscal year under review:
1. Attempt to improve the method of separating two strains of the larch sawfly by deriving linear discriminant functions based on ratios instead of total length of morphological parts, and the study of specimens from only one locality.
  2. Describe and illustrate a new genus of sawfly attacking spruce.
  3. Describe a new species of Pristiphora feeding on willow across Canada.
  4. Monitor the spread of the European spruce sawfly in Manitoba.
  5. Identify adults of Pristiphora and other sawfly genera, which I am the specialist from across Canada in the Canadian National Collection, Ottawa.

18. Accomplishment during fiscal year under review:

1. The use of Mahalanobis  $D^2$  statistic and discriminant function analysis failed to separate the late and early emerging populations of the larch sawfly from Riverton, Manitoba, which showed resistance and susceptibility respectively to the parasite Mesoleius tenthredinis. Further studies to separate these two populations by statistical methods is being discontinued because of the inability to place each measured specimen into one of the two categories with confidence.

2. Publication - Wong, H.R.  
1969. Reassignment of the Ambigua group of Pristiphora to a new genus Sharliphora (Hymenoptera: Tenthredinidae). Can. Ent. 101: 332-335.

3. Publication - Wong, H.R.  
1969. Pristiphora acidovalva, a new sawfly on willow (Hymenoptera: Tenthredinidae). Can. Ent. 101: 970-972.

4. Publication:- Wong, H.R. and W.G.H. Ives. 1969. The European spruce sawfly in Manitoba. Bi-Month Res. Notes. 25 (6): 47.

A special survey carried out in 1970 to determine the distribution of D. hercyniae in southeastern Manitoba, indicate that it has spread over 3500 square miles. The advance of the European spruce sawfly in Ontario and its absence in Northern Minnesota strongly suggest that this insect entered Manitoba from Ontario. The recovery of the European parasite Palexorista bohemica, which was released in various parts of Canada in 1934 to 1951, indicate that it also spread into Manitoba with its host.

5. The lack of funds in 1969-1970 prevented a trip to Ottawa to examine sawfly material in the Canadian National Collection.

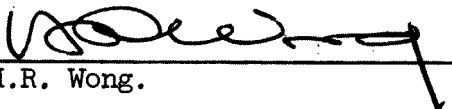
19. Goals for next fiscal year:

1. Identify adults of Pristiphora and other sawfly genera, which I am the specialist from across Canada in the Canadian National Collection, Ottawa.

2. Prepare a report on the spread of Diprion hercyniae in Manitoba.

3. Describe new species of Pristiphora from the Canadian Arctic.

20. Signature:

  
H.R. Wong.

March, 1971.



PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

- |                                                         |                 |                                                                                                  |              |
|---------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------|--------------|
| 1. Establishment:                                       | Edmonton, Alta. | Date Prepared:                                                                                   | March, 1971. |
| 2. Title:                                               |                 | Analyses and synthesis of<br>Forest Insect Disease<br>Survey historical data and<br>information. |              |
| 3. Investigator:                                        |                 | W.G.H. Ives.                                                                                     |              |
| 4. Year of Commencement:                                |                 | 1969.                                                                                            |              |
| 5. Estimated Year of Completion:                        |                 | Original indefinite.<br>Revision I 1974 II.                                                      |              |
| 6. Key Words not in Title:                              |                 | Population trends, computer<br>mapping data retrieval, in-<br>sects and environment.             |              |
| 7. Discipline:                                          |                 | Forest Insect and Disease<br>Survey.                                                             |              |
| 8. Problem Area Program:                                |                 | Detection and estimation of<br>tree pest damage.                                                 |              |
| 9. Estab. Proj. No.                                     |                 | Service Project No. NOR 089                                                                      |              |
| 10. Status at time of statement<br>preparation:         |                 | Active.                                                                                          |              |
| 11. Estimated total man-months<br>utilized to date:     |                 | Prof.: 9. Other: 24.                                                                             |              |
| 12. Man-months utilized in fiscal<br>year under review: |                 | Prof.: 8. Other: 16.                                                                             |              |
| 13. Man-month requirements in<br>next fiscal year:      |                 | Prof.: 6. Other: 12.                                                                             |              |
| 14. Location of Work:                                   |                 | Edmonton.                                                                                        |              |
| 15. Background Statement:                               |                 |                                                                                                  |              |

a - Project proposed by: Canadian Forestry Service.

b - Objectives: To determine if the large amount of data on insect infestations collected by the Forest Insect and Disease Survey during the past years can be utilized to help explain fluctuations in populations of forest insects, and thus lead to a better understanding of the factors contributing to insect outbreaks.

c - Need for project:                      Summaries prepared in the "Annual district ranger reports" contain a wealth of information on the incidence of the major forest insects throughout the region, as well as notes on some of the species of lesser economic importance. There is a large body of information on insects and diseases in files of the Survey. These data are on Remington Rand data cards and have now been transferred to magnetic tape. When the editing is complete (hopefully sometime in 1970) they should be available for various summaries and analyses.

Additional data on parasites are also available, but these required transferring to data sheets suitable for computer input, as they were recorded only on rearing sheets.

No thorough examination of the data for the Prairie Region has been undertaken. Only a thorough, comprehensive examination of the information compiled to date will reveal whether or not it is useful in furthering our understanding of fluctuations in forest insect populations. This project will undertake such an examination.

d - Co-operating Agencies:              Biometrics and Computer Science Branch: provide programming services, key-punching and eventually technical advice on appropriate analytical techniques.

16. Accomplishments to beginning of fiscal year under review:

Annual infestation histories for 11 of the most common forest insects in Manitoba and Saskatchewan have been mapped. The information has been transferred to data sheets and recorded on I.B.M. data cards.

Parasite rearing or dissecting records for 15 of the more common forest insects have been transferred to specially designed forms suitable for computer input.

The procedure for summarizing weather records contained in the "Monthly Record" has been decided upon, all of the necessary forms devised and printed, and most of the temperature data have been transferred to these forms ready for key punching.

17. Goals for fiscal year under review:

1. To update infestation histories as outlined in the Annual Ranger Reports.

2. To complete the summaries of parasite rearing and to transfer these data onto I.B.M. data cards (completed in 1969-70).

3. To summarize pertinent weather records for the period 1948-1968 on to data forms suitable for computer input and to transfer the data to I.B.M. data cards.

4. Subject to availability of computer time, to begin the editing and examination of the historical data recorded on magnetic tape, and to prepare summaries in a format compatible with that used in 1, 2, and 3 above.

18. Accomplishments during fiscal year under review:

The compilation of data on infestation histories, rates of parasitism, amount of precipitation and temperature deviations is now completed. The data have been key-punched, transferred to magnetic tape and edited. The historical file has not yet been received from Ottawa, so no editing of these data has been possible.

19. Goals for next fiscal year:  
historical file.

a. To complete editing of

b. Devise appropriate methods for summarizing data on historic file in format compatible with weather and parasite summaries.

c. Begin preliminary analyses to study the relationships between insect abundance and environment factors.

20. Signature:



W.G.H. Ives  
Investigator

March, 1971

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

1. Establishment: Edmonton, Alta.      Date Prepared: **March, 1971.**
2. Title:      Development of survey sampling techniques.
3. Investigator:      W.G.H. Ives.
4. Year of Commencement:      1968.
5. Estimated Year of Completion:      Original indefinite.  
Revision I    II.
6. Key Words not in Title:      Larch aspen tortrix, Choristoneura conflictana, sequential sampling.
7. Discipline:      Forest Insect and Disease Survey.
8. Problem Area Program:      Detection and estimation of tree pest damage.
9. Estab. Proj. No.:      Service Project No. **NOR 090**
10. Status at time of statement preparation:      Temporarily in abeyance.
11. Estimated total man-months utilized to date:      Prof.: 0.5.    Other: 3.0.
12. Man-months utilized in fiscal year under review:      Prof.: 0.      Other: 0.
13. Man-month requirements in next fiscal year:      Prof.: 0.      Other: 0.
14. Location of Work:      Large aspen tortrix sampling was conducted in Western Manitoba and in the Interlake Region. Other sampling might be conducted anywhere in the Region depending on the insect under consideration.
15. Background Statement:
  - a - Project proposed by: Canadian Forestry Service.

b - Objectives: To develop or modify survey sampling techniques for forest insects, as the opportunities arise, in order to improve the quality of the population estimates obtained by the Forest Insect Survey. Specifically, to develop a sequential sampling system for the large aspen tortrix.

c - Need for project: The Forest Insect and Disease Survey collects samples for a large number of insect species, and consequently must use general sampling methods for most of its work. The two methods most commonly used are beating and hand-collecting. Beating is a very satisfactory method for collecting most defoliating insects, but it is difficult to make the sample quantitative, as the sampling unit is largely undefined. Hand-picking is entirely qualitative. There is therefore a need for more quantitative sampling methods, especially for the most important insects. However, the time required to conduct this sampling must be kept to a minimum, otherwise the technique is impractical for survey use.

Sequential sampling, because it requires a smaller number of sample units for the equivalent degree of accuracy, is much more suitable for survey purposes than is conventional sampling. Sequential sampling techniques have been developed for several forest insects and have proved invaluable. The populations are still rated into broad categories, usually light, medium or heavy, but these terms are defined within meaningful limits, based on experience for each particular insect. The very subjective element involved in rating infestations based on beating or hand-picking is therefore removed and greater uniformity of results is obtained.

The large aspen tortrix is characterized by a rapid build-up and decline of populations, but no sampling techniques for measuring these have been devised. Preliminary data were therefore collected in 1968 to test the feasibility of developing a sequential sampling technique that might be used in the prediction of outbreaks of this serious aspen defoliator.

d - Co-operating Agencies: Possibly some input by Biometrics and Computer Science Branch.

16. Accomplishments to beginning of fiscal year under review:

1. The collections of egg masses made in 1968 yielded data that were encouraging. There were some sampling problems in heavily defoliated stands, as the oviposition sites were largely destroyed by feeding. The frequency distribution of numbers of egg-masses per leaf cluster appeared to follow the Poisson distribution.

2. Larval and egg mass samples were collected in 1969. The data have not yet been analyzed.
17. Goals set for fiscal year under review:
- a. To analyze the data collected in 1969.
  - b. If the data warrant, to devise sequential sampling techniques for sampling egg masses and larvae of the large aspen tortrix. Otherwise, collect additional data.
18. Accomplishments during fiscal year under review: Nil.
19. Goals for next fiscal year: No field work planned as reductions in staff and funds have made this impractical at the present time. The development or improvement of techniques suitable for survey use is considered to be important, but has been deferred until funding, at least, is more adequate.
20. Signature:



W.G.H. Ives,  
Investigator.

March, 1971

## REDUCTION OF LOSSES FROM BARK BEETLE AND WOOD

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BORING INSECTS

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Bark beetles are important pests in coniferous stands of Western Canada. Outbreaks can cause losses of many millions of cubic feet of wood, extensive deterioration of forests reserved for recreation or watershed purposes, and a general increase in fire hazard due to dead standing and downed trees.

Two species create a problem in this region; the mountain pine beetle on lodgepole pine and the spruce beetle on white and Engelman spruce. Studies on both species, and in particular those relating to the mountain pine beetle, have wide application in British Columbia and to other bark beetle species and their host trees.

Studies on the mountain pine beetle have the principal objective of developing a practical system for identifying in advance of the insect build-up, those stands which are susceptible and which may be destroyed within a brief few years. With predictive knowledge available, forest managers can remove endangered stands well in advance of any major invasion or build-up by the insects.

The spruce beetle studies are principally of a detection and appraisal nature in over mature and susceptible stands. The woods industry depends on a regulated and continuous supply of spruce over the next 20-25 years in the affected areas. Spruce beetle activity is disruptive to the management plans and will result in greatly accelerated wood depletion unless managers are to remove infested and susceptible stands as part of an established cutting program.

A large amount of wood is stored in the woods or in mill yards awaiting processing. Degrade occurs when wood borers are abundant and mass flights to the stored logs result in high levels of infestation. Studies are directed towards methods for estimating degrade in dollar values and in improved methods for protecting stored logs.

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

- |                                                         |                          |                                                                                                                                                                          |             |
|---------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 1. Establishment:                                       | Prairies Region.         | Date Prepared:                                                                                                                                                           | March, 1971 |
| 2. Title:                                               |                          | The role of blue stain fungi<br>in bark beetle infested<br>lodgepole pine.                                                                                               |             |
| 3. Investigator:                                        |                          | H.S. Whitney                                                                                                                                                             |             |
| 4. Year of Commencement:                                |                          | 1959.                                                                                                                                                                    |             |
| 5. Estimated Year of Completion:                        |                          | Original: 1972<br>Revision I: 1973                                                                                                                                       |             |
| 6. Key Words not in Title:                              |                          | Pathogenesis, mycangia, host<br>resistance, symbiosis, axenic<br>insects, SAI, CL.                                                                                       |             |
| 7. Discipline:                                          |                          | Pathology                                                                                                                                                                |             |
| 8. Project Group:                                       |                          | Reduction of losses from bark<br>beetles.                                                                                                                                |             |
| 9. Establ. Proj. No.                                    | A 042                    | Service Project No.                                                                                                                                                      | NOR 020     |
| 10. Status at time of statement<br>preparation:         |                          | Active                                                                                                                                                                   |             |
| 11. Estimated total man-months<br>utilized to date:     |                          | Prof.: 130                                                                                                                                                               | Other: 82   |
| 12. Man-months utilized in fiscal<br>year under review: |                          | Prof.: 12                                                                                                                                                                | Other: 12   |
| 13. Man-month requirements in next<br>fiscal year:      |                          | Prof.: 12                                                                                                                                                                | Other: 12   |
| 14. Location of Work:                                   |                          | Edmonton, East Kootenay Region<br>of B.C. Eisenhower Field<br>Station, BNP.                                                                                              |             |
| 15. Background Statement:                               |                          |                                                                                                                                                                          |             |
|                                                         | a - Project proposed by: | British Columbia Forest Service<br>and Canadian Forestry Service.                                                                                                        |             |
|                                                         | b - Objectives:          | 1. To elucidate the role of<br>the microorganisms in the death of coniferous trees attacked by bark<br>beetles. Blue stain fungi and yeast associated with mountain pine |             |



beetle attacked lodgepole pine will be the primary objects of study but other microorganisms associated with these and other bark beetles on other conifers will also be examined.

2. This project is part of an integrated study that includes population studies of the beetle and research on tree resistance (projects NOR 021 and NOR 022 respectively). The primary objective of the overall study is to provide forest managers with techniques for rating the bark beetle hazard to stands of lodgepole pine.

c - Need for project: The mountain pine beetle and its associated blue stain fungi are responsible for significant annual losses of lodgepole, white and ponderosa pines in western Canada and adjacent U.S.A. Exclusive of Vancouver Island, some 190 million board feet of these pines were killed in British Columbia and the Rocky Mountain National Parks alone in the ten (10) years from 1951 to 1961. In addition to causing direct monetary loss, epidemics of mountain pine beetles reduce the aesthetic value of stands, alter the species composition, increase fire hazard and force changes in management plans. Current knowledge is insufficient to permit forest managers to accurately forecast outbreaks or efficiently control existing populations. Attainment of the primary objective of this integrated study will enable managers to greatly reduce present losses by removing high risk stands before they are infested by bark beetles.

From a phytopathological point of view the integrated study centres around a disease caused by bark beetles and their associated microorganisms. Little is known of the causal effects of the associated microorganisms. A symbiotic mutualism has been proposed between bark beetles and their associated blue stain fungi. Also blue stain fungi are reported to be pathogenic to beetle attacked trees. The present project (NOR 020) is directed at obtaining knowledge of these vital relationships so as to assist forest managers in establishing hazard ratings for pine stands.

d - Co-operating Agencies: The B.C. Forest Service who have given permission for experimental plots to be established on their lands.

16. Accomplishments to beginning of fiscal year under review:

The blue stain fungi, including four new species, and the yeasts associated with the mountain pine beetle were identified. Ceratocystis montia and Europhium clavigerum were the most frequent blue stain fungi and Hansenula capsulata, H. holstii and Pichia pini the most common yeasts. Inoculations with C. montia and E. clavigerum resulted in resinous reactions similar to those of unsuccessful beetle attacks. Uninoculated controls produced a very minor reaction. It was concluded that the blue stain fungi were largely responsible for the resinous resistant response of the tree. It was observed that the greater the reaction to fungus inoculation, the greater the resistance to induced beetle attack.

Trees were rated resistant or non-resistant on the basis of their resinous response but intermediates could not be rated satisfactorily. The more apparent cytological and histological changes in tissues associated with beetle and fungal colonization were described.

Resinous reactions were twelve times longer from live than killed (autoclaved) inoculum of Europhium. High dilutions (1:10,000) of Europhium produced similar but smaller (1/3) resinous reactions compared to full strength.

More resins and volatiles, some of which were toxic to blue stain fungi, were present in sapwood associated with resistant reactions than in unaltered sapwood. Blue stain fungi and yeasts were isolated from a mycangium in the cardo portion of the maxillae of the mountain pine beetle. The mycangium was described with the aid of a scanning electron microscope.

Cirri of ascospores of C. montia, which stick to the insect, dispersed in pine resin but not in water. Cultures from dispersed spores were normal.

Larvae in rearing slabs became temporarily separated from all culturable microorganisms and fed in axenic phloem. Normal appearing adults were produced when this separation was made permanent.

Limited growth of axenic mountain pine beetles was obtained in unsupplemented autoclaved ground lodgepole pine phloem. Growth was greatly enhanced by killed brewers' yeast, mountain pine beetle associated yeasts, or the blue stain fungi and inhibited by two killed common contaminants of broods, Trichoderma sp. and Penecillium sp. Axenic beetles reproduced axenically in fresh bolts of lodgepole pine.

A Post Doctoral Transfer of Work was taken at the University of California, Berkeley. While there I collaborated with a research team studying tree diseases as factors predisposing trees to bark beetle attack. We found that an experimentally produced root disease on seedlings caused several pre-visual physiological changes in the seedlings. The pathogen studied also causes a root rot that predisposes mature trees to bark beetle attack. Two non-pigment producing fungi were found in non-stained dead sapwood of ponderosa pine attacked by the western pine beetle. The same fungi were associated with the bark beetle.

Ten publications and five reports were published up to 1970.

## 17. Goals set for fiscal year under review:

To complete the following publications:

Whitney, H.S. Association of blue stain fungi and other microorganisms with mining larvae of the mountain pine beetle. Proposed journal publication.

Whitney, H.S. Rearing mountain pine beetles in autoclaved lodgepole pine phloem supplemented with blue stain and other fungi. Proposed journal publication.

Whitney, H.S. Growth and production of the mountain pine beetle in lodgepole pine bolts in the absence of blue stain fungi. Proposed journal publication.

Whitney, H.S. Response of lodgepole pine to varying concentrations of blue stain fungus inoculum. Proposed Departmental Bi Mo. Res. Note.

Whitney, H.S. and R.A. Blauel. Dispersion of ascospores of Ceratocystis montia in pine resin. Proposed journal publication.

Whitney, H.S. Response of lodgepole pine to axenic virgin mountain pine beetles. Proposed Departmental Bi. Mo. Res. Note.

Whitney, H.S. Non-staining fungi associated with western pine beetle-attacked ponderosa pine in California. Proposed journal publication.

Helems, J., F.W. Cobb Jr., and H.S. Whitney. Effect of Verticicladiella infection on Host Tree Physiology. Proposed journal publication.

Parmeter, J.R. and H.S. Whitney. An annotated list of Rhizoctenia species. Proposed journal publication.

A major review is planned and new experimental work will be based on this revision.

## 18. Accomplishments during fiscal year under review: The following were submitted for publication.

Whitney, H.S. 1971. Association of Dendroctonus ponderosae Hopk. (Coleoptera: Scolytidae) with Blue Stain Fungi and Yeasts during Brood Development in Lodgepole Pine. Can. Ent. (in press)

Whitney, H.S. and R.A. Blauel, 1971. Ascospore Dispersion in Ceratocystis spp. and Euophium clavigerum in Conifer Resin Mycologia (in press)

Helms, J.A., F.W. Cobb, Jr., and H.S. Whitney, 1971. Effect of Infection by Verticillium Wagenerii on the Physiology of Pinus ponderosa. Phytopathology (in press).

This project was reviewed in connection with a review of the integrated study. This resulted in a research plan for assessing the hazard to lodgepole pine stands from the mountain pine beetle, and a statement of a general theory concerning the host-insect-microorganism interactions.

19. Goals for next fiscal year:

1. Compare the productivity of the mountain pine beetle with and without its associated microorganisms in fresh bolts of lodgepole pine.

2. Compare the colonization of lodgepole pine stems by the mountain pine beetle with and without its associated microorganisms.

3. Complete experimental work on rearing mountain pine beetles in ground phloem supplemented with killed blue stain fungi and yeasts that are associated with the beetle.

4. Proposed publications:

Whitney, H.S. Rearing mountain pine beetles in autoclaved lodgepole pine phloem supplemented with blue stain and other fungi. Journal publication.

Whitney, H.S. Growth and reproduction of the mountain pine beetle in lodgepole pine bolts in the absence of blue stain fungi. Journal publication.

Whitney, H.S. Non-staining fungi associated with western pine beetle-attacked ponderosa pine in California. Journal publication.

Parmeter, J.R. and H.S. Whitney. An annotated list of Rhizoctonia species. Journal publication.

Safranyik, L., D.M. Shrimpton, and H.S. Whitney. The mountain pine beetle in the pine forests of western Canada (proposed brochure).

20. Signature:

  
H.S. Whitney  
Investigator

March, 1971

PROJECT REVIEW STATEMENT

169

Fiscal Year: 1971-72

1. Establishment: Prairies Region                      Date Prepared: March, 1971
2. Title:                                                      Population studies of the mountain pine beetle
3. Investigator:                                              L. Safranyik
4. Year of Commencement:                                      1955
5. Estimated Year of Completion:                              Original 1970.  
Revision I, 1973
6. Key Words not in Title:                                      Dendroctonus ponderosae,  
sampling, spatial pattern,  
insect population quality,  
lodgepole pine, SA 1, CL.
7. Discipline:                                                      Entomology.
8. Project Group:                                                      Reduction of losses from bark beetles.
9. Estab. Proj. No.                      A 044                      Service Project No. NOR    021
10. Status at time of statement preparation:                                      Active
11. Estimated total man-months utilized to date:                                      Prof.:    90                      Other:    130
12. Man-months utilized in fiscal year under review:                                      Prof.:     7                      Other:    14
13. Man-month requirements in next fiscal year:                                      Prof.:     8                      Other:    12
14. Location of Work:                                                      Near Canal Flats and Invermere, B.C., at Eisenhower Field Station and in Edmonton, Alberta.
15. Background Statement:

a - Project proposed by: British Columbia Forest Service and Canadian Forestry Service.

b.- Objectives:                                                      1. Describe the distribution of beetle attacks over the host and the factors that influence this distribution.

2. Develop a sampling system which will be of sufficient sensitivity to permit detection, evaluation and prediction of population changes within limits of practicability.

3. Assess the effects of mortality factors on beetle population.

4. Relate the effects of mortality factors to population changes.

5. Assess the role of variations in mountain pine beetle phenotypes and abundance in relation to the physical and nutritional quality of the host.

6. Ensure current knowledge is being utilized by management agencies.

c - Need for project: The mountain pine beetle and its associated blue-stain fungi are responsible for significant annual loss of lodgepole, white and ponderosa pine in the Rocky Mountain National Parks, British Columbia, and the adjacent United States. Exclusive of the Vancouver Island, some 190 million board feet of western white, ponderosa and lodgepole pine were killed in British Columbia alone in the 10 years from 1951 to 1961. In addition to causing direct monetary loss, epidemics of the mountain pine beetle reduce the aesthetic value of stands and alter their species composition, increase fire hazard and force changes in management plans.

This project is part of an integrated study which includes research into tree resistance and the role of blue stain fungi, PRS 020 and PRS 022, respectively. The primary objective of the study is to provide forest managers with techniques for rating stands of lodgepole pine for beetle hazard. With that knowledge managers can greatly reduce present losses by removing high risk stands before they are infested by bark beetles.

d - Co-operating Agencies: B.C. Forest Service. The above agency gave permission to establish sample plots in infested stands under its jurisdiction.

16. Accomplishments to beginning of fiscal year under review:

The size, shape and orientation of the "optimum" sampling unit was established by studies of the relation of late stage brood and by a time study of sampling units of various sizes and shapes. The gradients of brood and attack density, both vertically and around the circumference of infested trees, were described and a mathematical description of attacks over the host, in term of bark thickness, was developed. A two-stage sampling system was developed to measure within generation mortalities and population trend. An equation was developed to predict infested bark surface area of lodgepole pine. "Surface area" tables have been drawn up covering trees in the 6 - 16 in. d.b.h. and 28-125 ft. height classes. These results represent the completion of objective 2 and a large part of objective 1. Work toward objective 3 progressed to the stage where 3 years data is available on mortality caused by woodpecker predation.

The study of the characteristics of the attack pattern has been completed. In general, the spatial arrangement of attacks and their distribution over lodgepole pine stems were found to be largely determined by distribution of bark niches suitable for attack initiation and by the combined thicknesses of the inner and outer bark. Attack density, maximum attack height and the attack harboring potential of individual trees are governed by bark roughness and bark thickness.

A preliminary study of the relations of attack ht., aspect, and moisture content of the outer sapwood on to beetle size (indexed by the width of the prothorax) has been completed.

17. Goals set for fiscal year under review:

1. To complete study of accuracy and efficiency of X-ray sampling in the larval and pupal stages of the beetle.
2. Continue study of the vertical flight intensity profile of attacking adult beetles and the method of colonization of host trees.
3. Initiate study of the effects of low temperature treatments in larval and pupal stages on the sex ratio of emerging adult mountain pine beetles.
4. Commence studies on the effect of seasonal changes within the host upon brood establishment and survival. Goal (4) was abandoned in favour of completing 3 papers on subjects not related to this study.

18. Accomplishments during fiscal year under review: Data was completed in studies of X-ray sampling efficiency and accuracy for the larval and pupal stages of the mountain pine beetle. This data now awaits analysis.

Field studies of the vertical flight intensity profile in relation to wind speeds, temperatures and 3 kinds of trapping methods are now completed. This study has been summarized in the form of a graduate thesis 'Host colonization by the mountain pine beetle in lodgepole pine stands' by R. Avis under my supervision. The thesis will be submitted to the Forestry Faculty, U.B.C., Vancouver, B.C. in the spring of 1971. Mr. Avis worked on this project as a student assistant during the past summer.

The study of the effects of low temperature treatments in larval and pupal stages on the sex ratio of the emerging adults was abandoned in favour of an alternate study "Size-related mortality of adult beetles in laboratory storage", due to delays in the adjustment and repair of the temperature controls of the low temperature rooms. The first draft of a manuscript describing the results of this study have been completed. The data has been collected and analysis completed for the study of the accuracy of the sine wave function for measuring heat units under Alberta conditions. The results are currently being summarized for publication.

List of publications:

- Safranyik, L. and K. Graham, 1971. Edge-effect bias in the sampling of sub-cortical insects. *Can. Ent.* 103:240-55.
- Safranyik, L. and R. Jähren, 1970. Emergence patterns of the mountain pine beetle from lodgepole pine. *Bi-Monthly Prog. Rept.* 26(2) p.p. 2.
- Safranyik, L. and R. Jähren, 1970. Host characteristics, brood density and size of mountain pine beetles emerging from lodgepole pine. *Bi-Monthly Prog. Rept.* 26(4).
- Safranyik, L. 1970. Some characteristics of the spatial arrangement of attacks by the mountain pine beetle on lodgepole pine (In press).
- Safranyik, L. and A.G. Raske. 1970. Sequential sampling plan for larvae of Monochamus (Coleoptera: Cerambycidae) in decked lodgepole pine logs. *J. Econ. Ent.* 6:1903-6.
- Raske, A.G. and L. Safranyik. 1970. Sequential sampling plan for determining infestation and damage levels of Monochamus (Coleoptera: Cerambycidae) woodborers in decked lodgepole pine logs in Alberta. Internal Report A-26 Canadian Forestry Service, Forest. Res. Lab. Calgary, Alberta, pp. 12.
- Baranyay, J.A. and L. Safranyik, 1971. Effect of dwarf mistletoe on growth and mortality of lodgepole pine in Alberta. Canadian Forestry Service Publication (In press).

19. Goals for next fiscal year:
1. Prepare a brochure for management agencies on the important tree, stand, climatic, and other environmental factors that affect the build-up of mountain pine beetle populations in the pine forests of western Canada with the recommendations for control.
  2. If necessary arrange visits to management agencies for the purpose of describing dangers and losses associated with bark beetles in their management areas.
  3. Initiate studies on the effects of low temperature on the larval stages of the beetle.
  4. Commence studies of the effects of nutritional and physical characteristics of the host on brood survival.



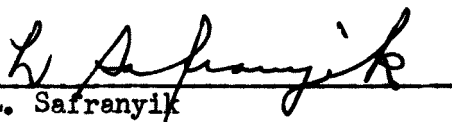
## Proposed publications:

Safranyik, L., H.F. Cerezke, W. Chow. Evaluation of the accuracy of the sine function for measuring heat units (proposed journal publication).

Safranyik, L., M.D. Shrimpton and H.S. Shitney. The mountain pine beetle in the pine forests of western Canada (proposed brochure).

Safranyik, L. Size-related mortality of mountain pine beetle adults during laboratory storage (proposed research note).

## 20. Signature:

  
L. Safranyik  
Investigator

March, 1971



in this study is that trees resist attack by sealing off the infected area with resinous compounds. Trees vary in their resistance and hence the cause of outbreaks is determined at least in part by the tree. Since the gross form of the tree's response has been defined the current specific objectives are to define the changes that take place in the stem, both chemical and anatomical, when it is attacked and then to determine those factors which influence the ability of the tree to resist insect attack.

c - Need for project: The mountain pine beetle and its associated blue-stain fungi are responsible for significant annual loss of lodgepole pine, western white and ponderosa pine in western Canada and the adjacent United States. Exclusive of Vancouver Island some 190 million board feet of western white, ponderosa and lodgepole pine were killed in British Columbia alone in the ten years from 1951 to 1961. In addition to causing direct monetary loss, epidemics of the mountain pine beetle reduce the aesthetic value of stands and alter their species composition, increase the fire hazard, and force changes in management plans.

This project is part of an integrated study which includes research into tree resistance, also insect behaviour and the role of blue stain fungi O20 and O21 respectively. The primary objective of the study is to provide forest managers with techniques for rating the bark beetle hazard to stands of lodgepole pine. With that knowledge managers can greatly reduce present losses by removing high risk stands before they are infested by bark beetles.

The natural methods for controlling insect populations are a variety of predators, insects, birds, etc., and the tree's natural attraction and resistance. The question of predators has been studied in this and other laboratories. Pheromone studies are under way in other laboratories. Little is known of the chemical and physiological mechanisms of tree resistance. When sufficient knowledge is on hand variations in the resistance of stands can be measured and hazard ratings for stands can be established.

d - Co-operating Agencies: B.C. Forest Service who have given permission for experimental plots to be established in their lands.

16. Accomplishments to beginning of fiscal year under review:

Resistance by lodgepole pine to invasion by bark beetles and/or blue-stain fungi is effected by an initial flow of oleoresin from the lesion followed by a gradual impregnation with resinous substances of the tissues adjacent to the wound. The flow of Oleoresin is due to a net synthesis of terpene hydrocarbon immediately after wounding. These components cause inhibition of growth of the blue-stain fungi. The free sugar fraction decreases rapidly immediately after wounding.

The resistant response is greatest in early July and then gradually lessens, thus resistance is declining at the usual time for beetle flight, i.e. mid July to early August. However, for any given tree, resistance is greatest in the lower bole i.e. in that part of the stem attacked by the beetles.

Moisture stress, as measured by the pressure bomb technique increases as the growing season progresses, reaching a maximum in mid summer. Resistant trees undergo lesser moisture stress during hot periods than non resistant trees. The insect flight has been observed to coincide with this period of greatest moisture stress for the tree.

17. Goals set for fiscal year under review:

1. To identify as many as possible of the compounds present in firstly the steam volatile fraction and then the neutral and acid lipids from the resistant reaction.

2. To work out the nutritional requirement of the other filamentous fungi normally associated with the mountain pine beetle.

Preliminary experiments have indicated that fungi used to date adapt to continuous growth on defined media, hence to obtain information relative to tree resistance fresh field isolates must be used. H.S. Whitney ( 024) will re-isolate these as they are available and work on this objective will proceed in conjunction with H.S. Whitney.

3. Maintain the present strain of tissue cultures. The strain in existence last year was lost due to problems created by the move. A new strain of lodgepole and also a ponderosa pine strain has been established. These will be used in a study of terpene synthesis as time permits.

4. Locate and then examine Ponderosa Pine and White Pine attacked by the mountain pine beetle to determine the nature of the response by each species. Also to examine White Spruce attacked by the spruce beetle.

18. Accomplishments during fiscal year under review:

1. Resistant response tissues taken from trees that had successfully resisted attack by the mountain pine beetle two years previously show steam volatile, acetone soluble and methanol soluble fractions about the same as a heartwood for the same tree (expressed as percentage of oven dried extracted tissue).

The steam volatile fraction from lodgepole pine heartwood, sapwood, resistant response tissue and tissues taken from the area surrounding the entrance hole of successfully attacking insects show the same components. No unusually high or unusually low concentrations of any components were observed in any of the response tissues analyzed with the exception of one non resistant sample with higher than normal myrcene. Variation in the relative composition of this fraction is greater between trees than between resistant or non resistant tissues relative to heartwood from the same tree. Nineteen components are normally present in steam volatile material, seventeen are identified. Two additional unidentified trace components are occasionally observed.

The acid fraction of the lipids from uninfected sapwood is about  $2/3$  fatty acid and  $1/3$  resin acid. The acid lipids from the heartwood contain the same components as the sapwood but fatty acids account for 30% or less of the total fraction. The remainder of the fraction is resin acid. Fifteen components are normally present of which seven are identified. Tissues subject to the blue stain fungi, whether resistant or non resistant, show a decreased amount of the fatty acid components.

The neutral fraction consists mainly of waxes and glycerides .

2. Ponderosa pine, White pine and White Spruce all have the same general response to bark beetle attack as lodgepole pine. There is an initial flow of oleoresin and deposition of resinous substances in the sapwood adjacent to the wound. White pine shows a narrow and deep zone of resin soaking, similar to lodgepole pine, whereas white spruce and ponderosa pine show a wide zone of resin soaking a few annual rings in depth. One of the white spruce studied (242 years old) showed evidence of resistance to bark beetle attacks periodically over the previous 147 years.

Preliminary extractions indicate that the oleoresin produced by these three species in response to insect attack is again due to a net synthesis of terpene hydrocarbon only.

19. Goals for the next fiscal year:

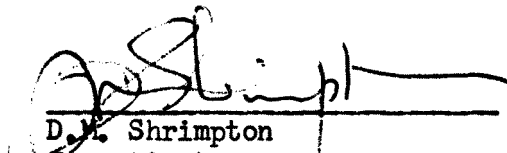
1. The extractive data will be finalized.
2. Lodgepole pine trees of all age classes from seedlings to overmature trees will be inoculated with Euophium at the end of June and again in late July, coincident with the beetle flight. Sufficient trees will be inoculated to allow a correlation of resistance with age and growth characteristics within each 20-year age class.
3. Beetles will be caged on white pine, ponderosa pine and white spruce and the development of the tree response determined.
4. Since seedlings show the same gross changes as mature trees in response to bluestain fungi, a histological study of the changes that occur in seedlings after inoculation has commenced and will continue this year.

5. Efforts will be continued to grow tissue cultures of lodgepole and ponderosa pines to be utilized for studies on oleoresin synthesis.

Proposed publications:

1. Heartwood Extractives of Lodgepole pine.
2. Production of Terpenes and Resin acids by lodgepole pine in response to wounding.
3. The mountain pine beetle in lodgepole pine forests of Western Canada. A monograph prepared for the forest manager in cooperation with L. Safranyik and H.S. Whitney.

20. Signature:

  
D. W. Shrimpton  
Investigator

March, 1971

PROJECT REVIEW STATEMENTFiscal Year: 1971-1972

- |                                                                                                                                 |                                                                                                 |                                                                                                                                                    |              |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1. Establishment:                                                                                                               | Prairies Region.                                                                                | Date prepared:                                                                                                                                     | March, 1971. |
| 2. Title:                                                                                                                       |                                                                                                 | Biology and control of Warren's collar weevil.                                                                                                     |              |
| 3. Investigator:                                                                                                                |                                                                                                 | H.F. Cerezke.                                                                                                                                      |              |
| 4. Year of Commencement:                                                                                                        |                                                                                                 | 1960.                                                                                                                                              |              |
| 5. Estimated Year of Completion:                                                                                                |                                                                                                 | Original 1968.<br>Revision I 1980.                                                                                                                 |              |
| 6. Key Words not in Title:                                                                                                      |                                                                                                 | <u>Hylobius warreni</u> , <u>Pinus contorta</u><br>var. <u>latifolia</u> , regeneration,<br>growth reduction, stand treatments,<br>B 19, sampling. |              |
| 7. Discipline:                                                                                                                  |                                                                                                 | Entomology.                                                                                                                                        |              |
| 8. Project Group:                                                                                                               |                                                                                                 | Reduction of losses from root-inhabiting insects.                                                                                                  |              |
| 9. Estab. Proj. No.:                                                                                                            | A 053                                                                                           | Service Proj. No.:                                                                                                                                 | NOR 024.     |
| 10. Status at time of statement preparation:                                                                                    |                                                                                                 | Active.                                                                                                                                            |              |
| 11. Estimated total man-months utilized to date:                                                                                |                                                                                                 | Prof.:                                                                                                                                             | 80 Other: 61 |
| 12. Man-months utilized in fiscal year under review:                                                                            |                                                                                                 | Prof.:                                                                                                                                             | 4 Other: 1   |
| 13. Man-month requirements in next fiscal year:                                                                                 |                                                                                                 | Prof.:                                                                                                                                             | 2 Other: 2   |
| (Estimates in 11, 12 and 13 exclude time spent by survey collectors and special surveys conducted by 'Damage Appraisal' group.) |                                                                                                 |                                                                                                                                                    |              |
| 14. Location of Work:                                                                                                           |                                                                                                 | Alberta Foothills, Edmonton Laboratory.                                                                                                            |              |
| 15. Background Statement:                                                                                                       |                                                                                                 |                                                                                                                                                    |              |
| a. Project proposed by:                                                                                                         | This project was proposed by Canadian Forestry Service, in response to requests of industry. It |                                                                                                                                                    |              |

entails damage impact studies to lodgepole pine and studies of the behaviour of the weevil within stands subjected to various treatments.

b. Objectives: The overall objective is to obtain information necessary for implementing pilot studies to test control methods, and thereby make concrete recommendations for weevil control in problem areas. Specific objectives are as follows:

1. Establish the time of initial invasion and subsequent spread and damage patterns of the weevil in young pine stands subjected to thinning, in newly stocked areas following clear-cutting with and without scarification treatments, and in stands having fertilizer treatment.

2. Determine experimentally the critical level of partial girdling necessary to cause tree death, and to establish a relationship between degree of girdling and amount of growth loss.

c. Need for project: Past studies of Warren's collar weevil have shown it to be present in pine and spruce stands throughout the Boreal Forest Region of Canada; white spruce and jack pine are its major hosts in Manitoba and Saskatchewan while lodgepole pine is the major host in Alberta. Larvae of this insect feed in the sub-cortical tissue in the root-collar zone of healthy trees, causing partial or complete girdling, open wounds and resinosis. Trees may be killed by girdling of the main stem and roots, suffer growth losses from partial girdling and repeated attacks, or the wounds may serve as points of entry for root and stem diseases.

Investigations in Alberta have been conducted in several even-aged lodgepole pine stands throughout the foothills area; the important findings of these studies are summarized as follows:

Populations of the weevil occur throughout the Lower and most of the Upper Foothills Sections (defined by Rowe, 1959). These Sections contain most of the prime pine pulp-growing stands in the province. Tree mortality due to larval feeding is usually less than 5% and occurs mostly in stands less than 30 years old; trees older than 30 years appear more resistant. Trees most frequently killed occur in the dominant and co-dominant classes.

Stands are invaded at age 6-10 years and attacks continue throughout stand development. Damage incidence normally increases directly with stand age, reaching a maximum near 60 years. At this age, 90-100% of trees have wounds of varying intensities. On 20-year-old trees with 50% girdling of the root collar circumference,



there was an av. 17.2% reduction in radial increment and an av. 11.5% reduction in terminal shoot length during a two-year period after attack. Further work is now necessary to determine what losses occur at higher percentages of girdling and in different stand age classes. The proportion of trees within stands having 50%+ girdling of the root collar varies widely but may exceed 10% in stands supporting high weevil populations.

The pattern of weevil attack within stands is influenced by tree diameter, tree age, stand density and depth of duff material at tree bases. Therefore, these stand variables should be taken into account for silvicultural control or when any manipulation of the stand is undertaken. Tree diameter was the single most important variable affecting weevil abundance. These results indicate that greater emphasis should be placed upon studies of the weevil in relation to clearcutting, scarification, planting, fertilization and especially thinning since this treatment is necessary in many of the overstocked stands in the Alberta foothills.

d. Co-operating Agencies: The co-operating agencies include forest insect and disease survey and liaison and management disciplines within the department, and also Alberta Forest Service and Northwestern Pulp and Power. All are co-operating mostly in an execution capacity.

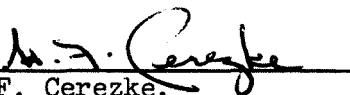
16. Accomplishments to beginning of fiscal year under review: Two 1/5-acre plots thinned in 1967 were re-examined for weevil populations and damage in 1969. After two years, there was a decline in weevil abundance, a decrease in the percentage of trees with current attacks and an increase in the percentage of trees with old attacks. It was suggested that thinning resulted in an initial concentration of the weevil on the residual trees since the percentage of trees with old and current attacks was still considerably higher than in control plots. Tree mortality was less than 1% and the percentages of trees with 50%+ girdling of the root collar circumference were 1.6 and 5.0 for the two plots. The long term effects of the weevil are still unknown.

Four series of mil-acre plots established in 1963 on sites which were clearcut and scarified during 1958-60 could not be re-examined in 1969 due to shortage of funds, assistance and temporary inaccessibility. Observations in the plots had been made in 1963, 1965 and 1967 for evidence of adult weevil feeding, larval damage, seedling heights, species and stocking/mil-acre. No evidence of the weevil had been found at the time of the last check.

An experiment was established in 20-25-year-old pine to determine the critical level of partial girdling necessary to cause tree death, and to establish a relationship between degree of girdling and amount of growth loss. The trees were partially girdled to simulate larval feeding and results of this study will be obtained at the end of the 3rd (1971) growing season. These results will contribute toward solving objective 2.

17. Goals set for fiscal year under review: Due to lack of travel funds and shortage of technical assistance no field work was done except a routine examination of all experimentally girdled trees to record changes in coloration and mortality. All remainder time available was spent on preparation of reports and publications.
18. Accomplishments during fiscal year under review: No field studies were made during this fiscal year; all time was devoted to preparing and completing the following reports and papers.
1. Cerezke, H.F. 1970. "Biology and control of Warren's collar weevil, Hylobius warreni Wood, in Alberta". Internal Report A-27: 28 pp.
  2. Cerezke, H.F. 1970. "A method for estimating abundance of the weevil, Hylobius warreni Wood, and its damage in lodgepole pine stands". For. Chron. 46 (5): 392-396.
  3. Cerezke, H.F. 1970. "Effects of weevil feeding on resin duct density and radial increment in lodgepole pine." Submitted to Can. J. For. Res.
  4. Cerezke, H.F. 1970. "Survey report of the weevil, Hylobius warreni Wood, in the Foothills of Alberta." Internal Report A-38: 40 pp.
- Considerable progress has been made on the preparation of the following papers:
5. "Effects of clearcutting on the survival of the weevil, Hylobius warreni Wood, in Alberta". Proposed Journal publication.
  6. "The spacial and temporal patterns of distribution of the weevil, Hylobius warreni Wood, in lodgepole pine stands in Alberta". Proposed Journal publication.
  7. "Behaviour patterns of Hylobius warreni Wood in relation to mating, egg-laying, feeding, dispersion and daily and seasonal activity. Proposed Journal publication.
19. Goals for next fiscal year: The experiment on partially girdled trees will be terminated in late August and the data will be gathered for analysis. The two 1/5-acre thinned plots will be re-examined, and if time is available, all other mil-acre plots in pine regeneration will be re-examined. No new plot establishments are anticipated in 1971-72. Time will be spent on completing papers 5, 6 and 7 listed under item 18.

## 20. Signatures:

  
H.F. Cerezke,  
Investigator.

March, 1971.

PROJECT REVIEW STATEMENT

184

Fiscal Year: 1971-1972

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Biology, impact and control of woodborers.
3. Investigator: H. Cerezke.
4. Year of Commencement: Commenced in 1967 by A.G. Raske and T. Szabo; transferred to H. Cerezke 1970.
5. Estimated Year of Completion: Continuous.
6. Key Words not in Title: Cerambycidae, Monochamus, Tetropium, white spruce, pine, sampling.
7. Discipline: Entomology.
8. Project Group: Increased Productivity of Wood Fibre, Stand Protection.
9. Estab! Proj. No.: A 054 Service Proj. No.: NOR 025.
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: Other:
12. Man-months utilized in fiscal year under review: Prof.: 2 Other: 1
13. Man-month requirements in next fiscal year: Prof.: 5 Other: 5
14. Location of Work: Edmonton; Prairies Region.
15. Background Statement:
  - a. Project proposed by: This project was proposed by Canadian Forestry Service in response to numerous requests received from industry and Provincial forest services on damage impact and control information.
  - b. Objectives: The objectives are to: (1) develop new, or improve existing sampling systems for estimating numbers of wood-borer insects in logs of different dimension, species and for standing trees; (2) develop new, or improve existing sampling systems for estimating

amount of degrade of timber and finished lumber caused by woodborers of different population densities; (3) develop and test different methods for control of woodborers in decked and undecked logs, infested lumber and on standing trees newly fire-killed.

c. Need for project: In the past few years, numerous requests have been received from industry and Provincial forest services for information on damage impact and methods of control of woodborers. These requests tend to fall into 3 major areas of concern, relating to the salvage and disposal of cut timber.

The first area of concern is in standing fire-injured and/or killed trees which are subsequently attacked by a variety of woodborer species. Cutting operations usually follow after fires in order to salvage the timber. If improperly timed, additional loss and degrade can result from the borer feeding galleries which may extend 3-4 inches into the wood. This is the case for Monochamus species which are the most economically important of the woodborers in Alberta.

A second area of concern is the risk of degrade from woodborer holes in piled, unpeeled logs in mill yards, and particularly in those left lying in the forest. Studies have shown that, on a per-log-basis, maximum monetary loss is about 30%, and that the losses are related directly to the number of woodborer holes per square foot of log surface (A.G. Raske and L. Safranyik, 1970). Thus, adequate population measuring techniques are necessary in order to relate population densities to the expected amount of degrade.

A third area of concern is in the finished product in which live insect material may remain in the wood after milling. Consequently, export lumber may be delayed or rejected, causing monetary losses or delays to the lumber company.

In order to provide answers to requests of industry and Provincial forest services, studies are now required in testing and improving of woodborer population measuring techniques, for refining and testing techniques of estimating monetary losses and in developing and testing various control methods.

d. Co-operating Agencies: Include Provincial Forest Service, various lumber companies and Forest Products Laboratory, Vancouver, Alberta Forest Products Ass'n. and Mackenzie Forest Service, all of whom are assisting in the execution phase of studies.

16. Accomplishments to beginning of fiscal year under review: Ecological and biological studies of the most economically important woodborer species in Alberta have been made, namely of Monochamus spp. and Tetropium velutinum.

Other cerambycid and buprestid species have been studied to a limited extent, including woodborers on aspen. A collection of insects found under bark of woodborer-infested pine and spruce logs was made and identifications of these were completed.

A larval rearing program of woodborer species was undertaken with Dr. Gardiner at Sault Ste. Marie to establish species identity in the larval stages. Hybridization studies were conducted with crosses of Monochamus oregonensis and M. scutellatus to establish their taxonomic relationships, and thereby define distributions and host preferences. The identification of chromosome pairs was assisted by Dr. G. Lanier of this laboratory. Some of these data have been reported on and submitted for publication.

Pine and spruce logs have been sampled in various parts of Alberta to establish densities of woodborers in decked and undecked pine and spruce logs, and in relation to position on log and position within decks. From these data a sequential sampling plan was developed for estimating the degree of Monochamus infestations. Infested pine logs have been sawn and the lumber product graded to establish a relationship between Monochamus damage intensity and percentage value-loss. Further refinements of this relationship and of the sampling technique are now required in addition to further testing on white spruce logs.

Studies of Monochamus control were undertaken, using two approaches. In the first, the effect of time-of-year of log felling was studied in relation to attack density of Monochamus. The main results were that logs cut in the fall and early winter were least attractive to Monochamus during the following summer, while logs felled during late winter, spring and early summer were most attractive. In the second approach to control, preliminary tests of the chemical PDB (para-dichloro benzene) were made on small experimental log decks, but the testing has not been extended to large commercial decks. The preliminary results of these tests have been promising. However, further testing is necessary using both crystalline and liquid forms of PDB. Tests with PDB as a fumigant should be made on lumber piled for export and infested with live wood-boring insects.

17. Goals set for fiscal year under review:

Because of the transfer of Dr. A. Raske and Mr. T. Szabo to other Regions, the goals set for 1970-1971 were reduced to report writing. Progress by Cerezke during 1970-1971 will consist of a woodborer literature survey and establishment of contacts with Alberta Forest Service and lumber Company personnel for problem and experimental areas, and to become familiar with the insects involved.

18. Accomplishments during fiscal year under review:

1. Safranyik, L. and A.G. Raske, 1970. Sequential sampling plan for Monochamus in lodgepole pine logs. Jour. Econ. Ent. 63 (6): 1903-06.

2. A.G. Raske and L. Safranyik. 1970. Sequential sampling plan for determining infestation and damage levels of Monochamus (Coleoptera: Cerambycidae) woodborers in decked lodgepole pine logs in Alberta. Internal Report A-26, 12 pp.

3. A.G. Raske. 1969. Insect families common under bark in Alberta, annotated check list and keys. Internal Report A-24, 60 pp.

4. G. Ianier and A.G. Raske. 1970. Multiple sex chromosomes and configuration polymorphism in Monochamus scutellatus - oregonensis complex. Submitted to Canad. J. Genetics and Cytology.

5. B.M. Dahl. 1971. Mortality of Monochamus larvae in slash fires. Submitted to Bi-Monthly Research Notes.

Contact by H. Cerezke has been established with several lumber companies, with Alberta Forest Service, Alberta Forest Products Assn., Mackenzie Forest Service and the Forest Products Laboratory in Vancouver for information and assistance in planning current studies of wood borers. Recommendations for control of wood borers in log decks have been supplied to two lumber company requests in Alberta.

19. Goals for next fiscal year: The following reports and papers are planned for completion by Dr. A. Raske.

1. Woodborer control with plastic sheeting and fumigation with para-dichloro benzene in conifer logs, Jour. publication.

2. Effect of time-of-felling on density of Monochamus Jour. publication.


3. Distribution of Monochamus larvae and other wood borer larvae within pine logs in Alberta, Jour. publication.

4. Review of biology and control of Monochamus and Tetropium; the economic wood borers of Alberta (Coleoptera: Cerambycidae). Information Report.

The studies of H. Cerezke will continue and extend those of A. Raske on aspects related to objectives 1, 2 and 3. Specifically, the sequential sampling plan will be tested on white spruce decked and scattered logs, taking into account (a) sample size, (b) log deck history and (c) orientation of logs. The distribution of wood borer populations within white spruce log decks will be examined with respect to diameter and length of log, light penetration, cutting history and geographical location. Depth of penetration

of wood borer larvae will be examined in relation to log diameter and thickness of sapwood and heartwood. Areas of fire-killed and damaged timber will be examined to determine wood borer infestations in relation to geographical location, tree size, fire history and burning intensity. Information will be obtained on the interpretation of new 1970-1971 lumber grading rules as they apply to "worm holes" and as a basis for estimating degrade of lumber due to borer damage.

20. Signatures:

  
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H.F. Cerezke,  
Investigator.

March, 1971.



PROJECT REVIEW STATEMENT

189

Fiscal Year: 1971-1972

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Climate in relation to the mountain pine beetle.
3. Investigator: J. M. Powell.
4. Year of Commencement: 1960.
5. Estimated Year of Completion: Original - 1964.  
Revision I - 1969.  
Revision II - 1970.
6. Key Words not in Title: Dendroctonus ponderosae, Pinus, outbreaks, habitat temperatures, valley climate, SA 1, CL.
7. Discipline: Entomology.
8. Project Group: Reduction of losses from bark beetles and wood borers.
9. Estab. Proj. No.: Service Project No.: NOR 096.
10. Status at time of statement preparation: Completed.
11. Estimated total man-months utilized to date: Prof.: 40 Other: 38
12. Man-months utilized in two fiscal years under review: Prof.:  $1\frac{1}{2}$  months Other: Nil
13. Man-month requirements in next fiscal year: Prof.: Nil Other: Nil
14. Location of Work: Calgary laboratory, Eisenhower Field Station, Invermere, B.C.
15. Background Statement:
  - a. Project proposed by: Canadian Forestry Service.
  - b. Objectives: Initially the project had wide objectives, but these were abbreviated after the first year of study, because of the pending reassignment of the investigator. The objectives were revised to determine: (1) the historic relationship between the important climatic factors and the occurrence of beetle outbreaks;

(2) the relationship between air and sub-cortical temperatures of attacked and unattacked trees at different heights in the stand; (3) the variability in summer climate in a mountain valley.

c. Need for project: Observations have indicated that outbreaks of D. ponderosae and other Dendroctonus species are often associated with prolonged drought periods. The important role of certain climatic factors in the rate of development of the various stages of the life cycle of the beetle has been shown, and also their effect on its mortality. Climatic factors also affect the susceptibility of the pine trees to attack. If a method of predicting possible outbreaks based on climatic conditions could be developed, control and management methods may be utilized to good effect.

d. Co-operating agencies: None.

16. Accomplishments to beginning of fiscal year under review: Data for all phases of the project had been collected, analyzed, published or were under preparation for publication. All but one aspect of the work under objective (1) had been published. Records of D. ponderosae outbreaks in western Canada were extracted from the literature and a detailed history of outbreaks and timber losses occurring in 15 physiographic regions from 1906 to 1960 was published. A paper giving distribution of the beetle and a cartographic history of outbreaks was also published as a report. A study was made of the climatic fluctuations and trends in British Columbia since the keeping of records, as part of an investigation to show whether relationships exist between trends in climate and beetle populations. Two papers were published, one on annual and seasonal temperature and precipitation trends in British Columbia since 1890, and the other on changes in amounts of sunshine. Two unpublished reports discussed the temperature trends and occurrence of drought in British Columbia. Under review, to complete objective (1), was a paper on an analysis of the correlation of fluctuations of seasonal weather and beetle populations which produced no significant results when considered over a time scale of 60 years, although many outbreaks occurred during periods of above normal spring and summer temperatures and below normal spring and summer precipitation.

The habitat temperatures of the beetle in lodgepole pine trees was compared with temperatures in non-infested trees and the surrounding air, and published in a paper to satisfy objective (2). The effects of height above ground, aspect, shading, bark thickness and subcortical moisture conditions on temperatures were considered.

Under objective (3) meteorological studies were carried out in 1960 and 1961 using a network of 19 stations in a beetle infested area of the Rocky Mountain Trench to give a better interpretation of local valley conditions. The stations varied in elevation from 2,700 to 5,000 feet and, during the summer, recordings were made of

soil temperature and moisture, air temperature, humidity and precipitation, and estimates were made of evaporation. Most of the data had been analyzed and eight of the stations formed the basis for an unpublished report on the summer climate of a tributary of the Upper Columbia River Valley.

17. Goals set for fiscal years under review: Complete the project by: preparing information report to complete objective (1) and revise the unpublished report on the summer climate of a mountain valley to satisfy objective (3).
18. Accomplishments during fiscal year under review: The report on the historical study of the relation of major mountain pine beetle outbreaks in western Canada to seasonal weather conditions was published. The unpublished report on the summer climate of a tributary of the Upper Columbia River Valley was revised and expanded to include data from eight other stations of the study and published.
- Powell, J.M. 1969. Historical study of the relation of major mountain pine beetle outbreaks in western Canada to seasonal weather. Can. Dep. Fisheries & Forest., Forest. Res. Lab., Calgary. Inform. Rep. A-X-23. 11 p.
- Powell, J.M. 1970. Summer climate of the Upper Columbia River Valley near Invermere, British Columbia. Can. Dep. Fisheries & Forest., Forest. Res. Lab., Calgary. Inform. Rep. A-X-35. June. 69 p.
19. Goals for next fiscal year: None, project completed.
20. Signatures:

J.M. Powell  
 J.M. Powell,  
 Investigator.

March, 1971

REDUCTION OF LOSSES FROM DEFOLIATING INSECTS

The spruce budworm and the larch sawfly are important defoliating insects in this region. In some areas up to near 50% of the white spruce has been killed as a result of many years of spruce budworm feeding. Management plans are being disrupted and considerable loss of valuable timber is occurring. Management agencies have altered cutting programs to remove endangered stands as quickly as feasibly possible. They are concerned also as to the effects of spruce budworm on regeneration in cutover stands.

Our program provides the management agencies with annual assessments of budworm populations. From these assessments priorities of logging are established by area. Research studies include an investigation to assess the effect of budworms on regeneration, techniques for measuring populations in mature stands, and assessing their impact.

The larch sawfly has greatly reduced the usefulness of tamarack in this region. Recurrent outbreaks have inhibited formation of trees and stands of commercial value. We believe if the larch sawfly were controlled tamarack in the future would constitute an important commercial tree species. Work to that end has been underway for many years with studies at first being concentrated on population dynamics utilizing the life table techniques. Biological control studies were carried on concurrently. The life table studies are mainly complete and no new work is planned.

The build up of a parasite from Europe released several years ago in Manitoba has been monitored for its abundance and effectiveness. Results to date are good and possibilities are promising this parasite may provide an effective control for larch sawfly. Work is continuing in this biological control study.

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Impact, biology, and control of the spruce budworm in northern Alberta and Northwest Territories.
3. Investigator: H.F. Cerezke.
4. Year of Commencement: 1968.
5. Estimated Year of Completion: Original 1973, subject to annual revision.
6. Key Words not in Title: Choristoneura fumiferana; Picea glauca; sample; defoliation; B18, 19; clearcutting; regeneration.
7. Discipline: Entomology.
8. Project Group: Reduction of losses from defoliating insects.
9. Estab. Proj. No.: A 052 Serv. Proj. No.: NOR 023
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 12 Other: 24
12. Man-months utilized in fiscal year under review: Prof.: 4 Other: 1
13. Man-month requirements in next fiscal year: Prof.: 5 Other: 5
14. Location of Work: High Level, Alberta; Ft. Smith, N.W.T.
15. Background Statement:
  - a. Project proposed by: Alberta Forest Service and Mackenzie Forest Service.
  - b. Objectives:
    1. Determine the distribution and impact of budworm in the commercial forests during the current year, and provide Alberta Forest Service, Mackenzie Forest Service and northern National Parks personnel with a seasonal assessment of the budworm, and advise on its likely hazard. Other staff members will assist in this appraisal.

2. Determine the biology of the insect with emphasis on selected parts of the life history and development of techniques for measurement of budworm populations.

3. Determine the formulation of control measures to be implemented as the need arises.

Former Project A050 has been incorporated into this project.

c. Need for project: The spruce budworm was first reported along the Mackenzie River in 1947. Since then it has been found in most stands of white spruce in the Mackenzie, Liard, Lower Hay and Slave River drainages of the Territories, and along the Athabasca, Peace, Wabasca and Chinchaga rivers of northern Alberta. These areas presently support most of the merchantable mature and overmature white spruce timber in northern Alberta and the Territories. Logging companies are currently operating in several stands in the Footner Lake and Athabasca Forest Management Units in Alberta, in Wood Buffalo National Park and in the Mackenzie Forest of the Territories, where an annual harvest in excess of 70 MM f.b.m. is removed. Obvious spruce budworm damage currently exists throughout many of these stands in the form of defoliation, tree mortality and dead tops. In one such area in northern Alberta a re-alignment of the cutting program has occurred following recommendations of the Canadian Forestry Service to give priority for removal of high-risk stands, and thereby reduce overall losses. As a further consequence to the budworm damage, salvage operations are costly and fire and budworm hazard reduction costs are increased. Thus there is an immediate need to appraise timber berth areas for spruce budworm abundance and its effects upon the host, and to provide management with guidelines to reduce losses where possible.

With removal of the timber the problem of budworm damage to spruce regeneration becomes important. Ground surveys have shown that spruce regeneration and advanced growth are generally lacking in many of the mature and overmature stands, and are severely damaged by the budworm in other stands. Little is known of the potential risks to young stands adjacent to or removed from mature timber, nor of the relative susceptibility of different stand types and age classes. Information is also lacking on the behaviour and survival of budworm populations in spruce regeneration.

Good cone crops of white spruce occur every 4-6 years, and budworm larvae are known to feed on the staminate flowers as well as in the developing cone. The potential destruction of cone crops by the budworm is unknown as is the relationship between good cone years and budworm population density and survival.

d. Co-operating Agencies: Co-operating agencies include the Alberta Forest Service, Mackenzie Forest Service, Canadian National Parks and various lumber companies. The type of co-operation has involved planning and executing of aerial and ground surveys of the budworm, in establishment of experimental areas and in the establishment and main-

tenance of a field station at Footner Lake in northern Alberta.

16. Accomplishments to beginning of fiscal year under review:

Budworm infested stands along the Peace, Chinchaga, Wabasca, and Slave rivers were located and outbreaks were mapped during 1968, 1969 and 1970 from aircraft. Other infested stands were located from the ground. Collections of 360 branch samples were made from 30 non-infested trees and the following characteristics were measured on each: shoot length, numbers of terminal buds, branch surface area, number of needles and dry needle weights. Patterns of these characteristics within tree crowns were determined and are being used in the development of budworm sampling techniques. Other branches from budworm defoliated trees were examined similarly. Radial increment patterns were determined for all sampled trees.

Semi-permanent field plots were established for budworm population measurements, and to obtain information on the defoliation pattern within trees and between trees within large stands and within residual leave strips of uncut timber.

Collections of the budworm life stages were made throughout 1969; from these data the number, size range and duration of larval instars were determined. Phenological measurements of the host and temperatures were made to relate with larval development. Other collections of pupae established sex-ratios and size distributions of the sexes. Adults reared from pupae provided several additional criteria useful for characterizing populations.

Field trapping of male moths with two types of 'female-baited' traps provided relative population estimates, information on the duration of the adult stage; male flight activity and the choice of best trap design.

Studies were made toward development of a sampling plan for the egg stage. Limited sampling and field observations were also made on 2nd-3rd instar larvae. These data have helped to determine which stages of the life cycle can be feasibly sampled for population estimates.

Preliminary work was done toward relating budworm population density to degree of defoliation, and in estimating percentage defoliation of current shoot growth.

Four major insect parasites of late instar larvae and pupae, and 23 potential bird predator species have been identified.

17. Goals for fiscal year under review:

Semi-permanent field plots were to be examined for budworm activity but only the degree of defoliation to be estimated due to shortage of funds and assistance. Consequently, all

other goals were deleted. An attempt was to be made to map spruce budworm abundance from aircraft along two major drainages within the Footner Lake Forest, and a report will be prepared for Alberta Forest Service, Mackenzie Forest Service and northern National Parks personnel, summarizing observations of the budworm in 1970. Data collected in 1968 and 1969 analyzed but no formal reports planned.

A problem related to the general and specific use of cumulated heat-units in ecological work will be analyzed jointly with two other researchers.

18. Accomplishments during fiscal year under review:

Management agencies in Alberta, Wood Buffalo National Park and Mackenzie Districts received information describing the abundance, general distribution and impact of spruce budworm in commercial spruce forests surveyed within their regions in 1970. Alterations in cutting plans have been taken by some agencies as a result of this information. The tree crowns of trees in semi-permanent field plots were examined for amounts of defoliation, but spruce budworm populations were too low to provide adequate information. A field trip was made at the request of National Parks personnel to determine causes of degrade in spruce budworm infested timber in Wood Buffalo National Park, and to advise on possible solutions. Two meetings have been held with Alberta Forest Service to discuss and formulate license cutting conditions and spruce budworm hazard reduction methods in a high risk area in Northern Alberta. Preliminary arrangements have been made with Alberta Forest Service to establish an experiment to test the effects of spruce budworm on young spruce regeneration in clearcut areas. Analyses of the cumulated heat-unit study have been largely completed.

Stevenson, R.E. 1970. "The spruce budworm in northern Alberta: with emphasis on the Wabasca outbreak." Internal Report A-28, 13 pp.

Cerezke, H.F. 1970. Spruce budworm conditions in northern Alberta and Northwest Territories. Mimeograph Report, 3pp.

19. Goals for next fiscal year:


Aerial and growth surveys of commercial forests in northern Alberta and Northwest Territories will be made and a special report summarizing current budworm distribution, impact and hazard will be prepared for distribution to Alberta Forest Service, Mackenzie Forest Service and National Parks personnel. Test and evaluate two methods of sampling spruce budworm; one for late-instar larvae, the other for adults. Obtain estimates of current defoliation and test if these can be related to budworm abundance. Describe the life history of the budworm, its main predators and parasites, and how its life stages relate to the seasonal phenological development of the host. Determine the distribution of late-instar larvae within foliage of the host tree. Describe foliage morphology and patterns in tree crowns for selection of a sampling universe of late-instar larvae and a representative



sample of defoliated branch. Examine the behaviour of late-instar larvae with respect to their feeding and dispersal patterns. Test methods of collecting, preserving and measuring foliage and budworm material. Complete arrangements for planting of 2000 white spruce seedlings. Undertake preliminary work toward relating years of budworm feeding to tree-top killing and tree mortality. Prepare a paper for publication jointly with L. Safranyik and B. Chow on the topic:

"The evaluation of the sine wave function for heat-unit accumulations under Alberta conditions."

20. Signature:

  
\_\_\_\_\_  
H.F. Cerezke,  
Investigator.

March, 1971.



2. To measure the density of parasites and predators attacking the larch sawfly.

3. To measure mortality attributable to various agents affecting the larch sawfly.

4. To monitor weather and water level fluctuations in the study plots.

5. To measure the amount of defoliation caused by the larch sawfly and the growth and survival of larch trees.

c - Need for project: The objectives of **PRS 098** can only be attained through analyses of a comprehensive body of data on the larch sawfly and its environment. To attain this, the major elements of the ecosystem in which the larch sawfly occurs must be monitored.

d - Co-operating Agencies: Biometrics Research Services, Vertebrate Biology Section, Entomology Research Institute; Manitoba Departments of Natural Resources and Tourism and Recreation.

16. Accomplishments to beginning of fiscal year under review:

Sampling techniques for eggs, larvae, cocoons and adults of the larch sawfly were developed and standardized. Problems in measuring weather were solved by adapting available equipment for use in inaccessible areas without line power. Simple methods of measuring water table fluctuations and of estimating tree defoliation were developed. More data have been processed, placed on punch cards, and preliminary summaries and analyses completed.

17. Goals set for fiscal year under review:

Continue measurement of larch sawfly populations, associated factors, processing of the data, and preparation of preliminary summaries.

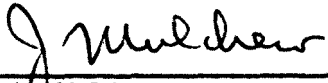
18. Accomplishments during fiscal year under review:

The measurements were made, the data transferred to punch cards, and preliminary analyses and life table data compiled. In 1970 populations in most plots continued to decline, particularly in those areas where the introduced parasite, Olesicampe benefactor had been released. Results of 1969 operations were completed.

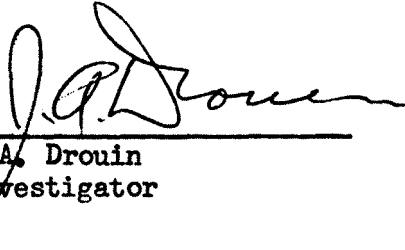
19. Goals for next fiscal year: 1. To monitor larch sawfly populations and mortality factors, especially the parasite complex, in sufficient detail in three study plots to provide data for assessing the impact of O. benefactor, Mesochorus dimidiatus and the Bavarian strain of Mesoleius tenthredinis on population trends.
20. Signature(s):



W.G.H. Ives  
Investigator



J.A. Muldrew  
Investigator



J.A. Drouin  
Investigator

March, 1971

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Larch sawfly biological control.
3. Investigator: J.A. Muldrew.
4. Year of Commencement: 1950.
5. Estimated Year of Completion: 1975.
6. Key Words not in Title: Pristiphora erichsonii, Olesicampe benefactor, Mesoleius tenthredinis, Mesochorus dimidiatus, parasites, encapsulation, hyperparasites, Larix, Boreal Region "B".
7. Discipline: Entomology.
8. Project Group: Reduction of losses from defoliating insects.
9. Estab. Proj. No.: MS 050 Serv. Proj. No.: NOR 061
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 252 Other: 282
12. Man-months utilized in fiscal year under review: Prof.: 8 Other: 2
13. Man-month requirements in next fiscal year: Prof.: 7 Other: 2
14. Location of Work: Headquarters - Edmonton. Fieldwork - Red Rock Lake Field Station, Rennie P.O.
15. Background Statement:
  - a. Project proposed by: Canadian Forestry Service.
  - b. Objectives:
    1. To achieve control of the larch sawfly in North America.
    2. To contribute to the population dynamics study of the larch sawfly and thereby to gain understanding of the role and relative importance of the various factors and processes that determine its abundance.

c. Need for project: Tamarack is the fastest growing conifer in the Boreal forest. If protection from the larch sawfly could be obtained there would undoubtedly be an increased use of tamarack for pulpwood, sawtimber, piling, poles, ties, veneer, etc., and its use in forest plantings would increase. Moreover, with sawfly control, Larix spp. would be used more frequently in park, boulevard and home-ground ornamental plantings.

d. Co-operating Agencies: Canada Department of Agriculture; Research Institute, Belleville and Entomology Research Institute, Ottawa (execution); Biometrics Research Services.

16. Accomplishments to beginning of fiscal year under review:

The death of Mesoleius tenthredinis eggs in the resistant larch sawfly strain was found to be due to their encapsulation by host blood cells. The spread of the resistant strain from Manitoba almost to the limits of tamarack was monitored. A strain of M. tenthredinis from Bavaria was found to have a greater ability to avoid encapsulation in the resistant sawfly than had the "native" strain. Hybridization experiments showed this ability was transmitted as a dominant factor. Releases of this strain in Manitoba have resulted in lower levels of encapsulation and a progressively increasing percentage parasitism by M. tenthredinis. From 1961 to 1964, six species of parasites from overseas were released. One of these, Olesicampe benefactor, is well established. Parasites reared from hosts collected in Manitoba have been successfully relocated in Saskatchewan, New Brunswick, Nova Scotia and Maine. Where first released, parasitism reached a high level within three to four years and has remained high. Host densities have progressively decreased and life table data indicate that O. benefactor has played a key role in causing this. The parasite is dispersing well. Studies were completed on differentiating the smaller hosts parasitized by O. benefactor from the larger normal hosts. The hyperparasite Mesochorus dimidiatus, which attacks O. benefactor in Europe, was recovered from three release points in Manitoba. Studies in co-operation with the Entomology Research Institute, Ottawa, revealed that the hyperparasite had a holarctic distribution before O. benefactor was released in America.

17. Goals set for fiscal year under review:

a. To continue studies involving the marking of the larch sawfly larvae and cocoons with vital stains. This study falls under objective (b); its goal being to compare the relative survival of non-parasitized and parasitized cocooned hosts for each of the major mortality factors affecting them and under differing microhabitat conditions.

b. To continue studies on the biology and impact of O. benefactor at the release points in Manitoba and Saskatchewan.

c. To initiate studies on the impact of M. dimidiatus on the efficiency of O. benefactor and on the biology of the hyperparasites.

d. To monitor collections of larch sawfly received from the Maritime Provinces and Pennsylvania with respect to resistance to M. tenthredinis.

18. Accomplishments during fiscal year under review:

1. Reports and papers:

Turnock, W.J. and J.A. Muldrew. Pristiphora erichsonii (Htg.), Larch Sawfly. (Hymenoptera: Tenthredinidae). In Biological Control Programs against Insects and Weeds in Canada. 1959-1968 (in press).

Turnock, W.J. and J.A. Muldrew. The use of Parasites in Biological and Integrated Control of Forest Pests. In Integrated Control of Forest Insects, Proc. Forest Insect Population Dynamics Workshop, New Haven, Conn. U.S.D.A. For. Service Research Paper (in press).

2. The field and laboratory work in the study involving the marking of larch sawflies with vital stains was completed.

3. O. benefactor continued to parasitize about 95% of the sawflies in the Pine Falls and Hodgson plots in 1970 and host cocoon populations in these plots dropped to 27% and 9%, respectively, of the 1969 levels. Maximum dispersal distance increased from 33 miles in 1969 to 54 miles in 1970. Rapid establishment occurred at The Pas, Manitoba, where, following release in 1968, parasitism was 40% in 1969 and 61% in 1970. In 1970 a release was made near St. Labre, Manitoba (864 adults) and collections of cocoons in the fall showed attack figures of 23% at the release point and 6% 100' away.

4. The 95% parasitism by O. benefactor at Pine Falls occurred in spite of the parasite being itself attacked by M. dimidiatus at a rate of 61% in 1968 and 84% in 1969. The incidence of attack by M. dimidiatus also increased at Hodgson (4% to 41%) and at Riverton (13% to 17%).

5. Experimental work was carried out to determine fecundity and longevity of O. benefactor but analysis of the results remains.

6. Rearing results for cocoons from the Rennie plot showed a parasitism by M. tenthredinis of 58%. The progressive increase in parasitism by this species since 1966, when it was 4%, confirms the establishment of the Bavarian stain. At the Hodgson release point there was an indication of establishment, namely 41% parasitism with 29% of attacked hosts showing resistance.

7. Dissection of the Maritime collections again indicated the progressive change in Nova Scotia from a former condition of high susceptibility to the present one of almost typical resistance. New Brunswick material showed a higher susceptibility than in past years but it could still be classed as "typically resistant". The Pennsylvania material again showed a moderate degree of resistance.

8. The early- and late-emerging strains of larch sawfly selected from Riverton-collected sawflies by R.J. Heron again showed that the early-emerging strain was typically susceptible and the late-emerging typically resistant. Morphological analysis failed to distinguish these strains with certainty.

19. Goals for next fiscal year:

This will be the final year of intensive plot studies.

(a) A combined release of O. benefactor and M. dimidiatus (approximately equal numbers of each) in the Agassiz life table plot to determine if the former can survive and increase in spite of the detriment of the latter when each starts "on an equal footing".

(b) A collection of approximately 40,000 larch sawfly larvae from the O. benefactor release areas to be reared at the Whiteshell Field Station to provide material for a "demonstration biological control release" in 1972 probably along the Trans Canada Hwy. east of McMunn, Manitoba.

(c) Completion of analysis of the study involving marking of larch sawflies with vital stains.

(d) Completion of analysis of the O. benefactor fecundity study.

(e) Obtaining additional data on the relative food-consumption and damage potential of hosts parasitized by O. benefactor versus non parasitized hosts.

(f) Continuation of impact and dispersal studies for both O. benefactor and M. dimidiatus.


(g) Monitoring sawfly populations at and around the release points for Bavarian M. tenthredinis.

(h) Monitoring of collections of larch sawfly received from the Maritimes (on a reduced scale) and Pennsylvania with respect to resistance to M. tenthredinis.

(i) To co-operate with W.J. Turnock in the preparation of a paper tentatively entitled "History and etiology of two major continental outbreaks of the larch sawfly in North America".



20. Signature:

  
\_\_\_\_\_  
J.A. Muldrew,  
Investigator.

March, 1971.



2. To monitor the incidence of parasitism of O. benefactor by the hyperparasite Mesochorus dimidiatus Holmgren.

c - Need for project: The larch sawfly is a serious defoliator of larch throughout central Canada. Outbreaks at the turn of the present century have been credited with killing most of the merchantable tamarack in this area. An earlier attempt at biological control, involving Mesoleius tenthredinis (Morley), was successful at first, but became ineffectual when the host developed resistance to the parasite by means of encapsulating the parasite's eggs.

Olesicampe benefactor Hinz, an Ichneumonid parasite of the larch sawfly, was introduced from Europe and first released near Pine Falls in 1961. Subsequent releases were made near Riverton in 1962 and 1963, Crutwell in 1964, 1965 and 1966, Hodgson in 1967 and The Pas in 1968. The parasite is known to be successfully established at the first four of these locations, thus providing unique opportunity to study the dispersal of a parasite in a new environment.

The initial dispersal from Pine Falls, Riverton and Hodgson was under the surveillance of the Larch Sawfly Problem Area Group (Muldrew 1967). The Forest Insect and Disease Survey has been monitoring the spread at Crutwell since the time of release, and has been monitoring the spread from Pine Falls and Riverton since 1967. The high level of Lake Winnipeg in 1966 practically eliminated the larch sawfly at the Riverton release point. Consequently, very little information on long-range dispersal is available for this area. So far, most of the dispersal data have been collected for the Pine Falls release area.

In 1967, O. benefactor was recovered 1.7 miles north of the Pine Falls release point and 1.8 miles south. Corresponding figures for 1968 are 7.2 and 8.3 miles. The measurable spread of the parasite was therefore very slow for the first 6 years following release, but now appears to be accelerating. If this is so, it may soon be impossible to provide a detailed assessment of its spread, even with the survey surveillance. Our permanent larch sawfly sampling plots should nonetheless provide some indication of when the parasite reaches different areas within the region, as well the larch sawfly population dynamics plots.

Reference: Muldrew, J.A. 1967. Biology and initial dispersal of Olesicampe (Holocremnus) sp. nr. nematorum (Hymenoptera: Ichneumonidae), a parasite of the larch sawfly recently established in Manitoba. Can. Ent. 99: 312-321.

d - Co-operating Agencies: Larch Sawfly Problem Area.  
Work is done in consultation with Mr. Muldrew. With staff reductions, he may also assist in collecting material in 1970 near Pine Falls.

Entomology Research Institute:  
Provide identification when needed of the parasite and its hyperparasite.

16. Accomplishments to beginning of fiscal year under review:

The spread of Q. benefactor was monitored as indicated in background statement. Preliminary results from 1969 collections indicate that Q. benefactor has now spread 25-30 miles from the Pine Falls release area and about 8 miles from the one at Riverton. A hyperparasite of Q. benefactor, Mesochorus dimidiatus Holmgren, has been recovered from both of these areas, and is causing considerable concern because it may seriously affect the effectiveness of Q. benefactor.

Emergency of material collected in 1969 is not yet complete so the incidence of hyperparasitism is not yet known.

17. Goals set for fiscal year under review:

1. To continue to monitor the spread of Q. benefactor in as much detail as possible.

2. To monitor the spread and/or build-up of the hyperparasite M. dimidiatus in as much detail as possible.

18. Accomplishments during fiscal year under review:

Populations of Olesicampe benefactor Hinz, remained high at the three original release points, 94 per cent at Pine Falls, 96 per cent at Riverton and reached 95 per cent at Hodgson for the first time. At Crutwell, Saskatchewan, parasitism increased from 10 per cent in 1968 to 40 per cent in 1969. Dissection of cocoons collected in 1970 indicate that Q. benefactor has probably spread to the Nesbit Provincial Forest 16 miles east of Crutwell. This is surprising as larch is very scattered in this area. Q. benefactor has also spread at least 50 miles from the original release point at Pine Falls having been recovered in the Agassiz and Rennie life table plots 43 and 54 miles away. The hyperparasite, Mesochorus dimidiatus Holmgren attacked 84, 67 and 41 per cent of Q. benefactor at Pine Falls Riverton and Hodgson respectively, and has been recovered on the Rennie life table plot. How long Q. benefactor can thrive at the present level when subjected to such high levels of hyperparasitism is open to question. This

19. Goals for next fiscal year:

a. To continue to monitor the spread of Q. benefactor in as much detail as possible.

b. To monitor the spread and/or build-up of the hyperparasite M. dimidiatus in as much detail as possible.

20. Signature:



W.G.H. Ives  
Investigator

March, 1971

PROJECT REVIEW STATEMENT

208

Fiscal Year: 1971-72

1. Establishment: Prairies Region                      Date Prepared: March 1971
2. Title:                                                      Natural Control of the Larch Sawfly
3. Investigator(s):                                        W.G.H. Ives and J.A. Muldrew
4. Year of Commencement:                                1966
5. Estimated Year of Completion:                      Original: Indefinite  
Revision I. 1972
6. Key Words not in Title:                              Pristiphora erichsonii, Larix,  
population dynamics, ecosystem  
modelling, biological control.
7. Discipline:                                              Entomology
8. Project Group:                                            Reduction of losses from defoliating  
insects. Associated projects are:  
  
PRS 059 Larch sawfly ecosystem  
measurement.  
  
PRS 060 Larch sawfly, impact of  
Bessa harveyi.  
  
PRS 061 Larch sawfly biological  
control.
9. Estab. Proj. No.:                                        Service Project No. NOR 098
10. Status at time of statement  
preparation:                                                Active
11. Estimated total man-months  
utilized to date:                                           Prof.: 300.            Other: 480.
12. Man-months utilized in fiscal  
year under review:                                        Prof.: 4.              Other: 12.
13. Man-month requirements in  
next fiscal year:                                           Prof.: 6.              Other: 12.
14. Location of Work:                                      Whiteshell Provincial Park,  
Manitoba, and Edmonton, Alberta.

## 15. Background Statement:

a - Project proposed by: Canadian Forestry Service

b - Objectives: 1. To determine the causes for the continuing damage caused by the larch sawfly to larch growth throughout Canada.

2. To explore the ecological relationship between the insect pest and its environment.

3. To elucidate the population dynamics of the larch sawfly.

4. To expose possible methods of reducing the damage done by the larch sawfly.

5. To determine the effects of sawfly defoliation of host stands.

c - Need for project: Since 1940, defoliation by the larch sawfly has severely affected larch growth and survival throughout Canada. Because of these attacks, larger trees have died - younger trees have failed to produce normal growth. Unless methods of preventing larch sawfly attacks can be developed, large areas of land will continue to be unproductive and planting programs utilizing larch for fibre production or aesthetic purposes cannot be encouraged.

d - Co-operating Agencies: Brometrics Research Services.

## 16. Accomplishments to beginning of fiscal year under review:

The major effort within this project has been in planning and directing the implementation of projects designed to develop and test sampling techniques, to determine the relationships between variables in the system, and to apply existing analytical procedures to the population data. Comprehensive syntheses have been delayed because the sawfly populations were declining throughout most of the history of the project. A minor peak of populations occurred in the years 1965-1968 and the data now cover an almost complete gradation.

## 17. Goals set for fiscal year under review:

a. To review projects and sampling procedures on the basis of the value of their contribution to the analysis of the larch sawfly ecosystem.

b. To analyse and prepare for publication the data on the statistical characteristics of larch sawfly population estimates.

## 18. Accomplishments during fiscal year under review:

(a) Sampling procedures have been thoroughly reviewed. Essential data for studying the impact of Olesicampe benefactor, Mesochorus dimidiatus and the Bavarian strain of Mesoleius tenthredinis can be collected with less staff than previously utilized by eliminating time-consuming <sup>or</sup> specialized sampling procedures. The first category has been dictated by cuts in student support, the latter by loss of key personnel.

(b) Flow charts have been prepared outlining procedures to be followed for calculating the proportions falling into various categories for data collected on larvae at three periods in the life cycle: 1) feeding larvae; 2) falling larvae; and 3) larvae in cocoons. These data sources provide a comprehensive set of estimates of the various parameters and require approximately 300 different estimates to give all possible combinations of factors.

Data on adult populations have been coded and are ready to send to Biometrics Research Services for key punching.

## Publications:

Turnock, D.J., 1970. The organization of a study of a biological system. *Manitoba Entomologist* 3:34-38.


## 19. Goals for next fiscal year:

1. To determine the relative importance of various mortality factors affecting the immature stages of the larch sawfly.

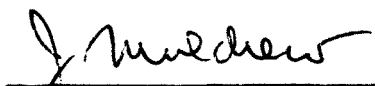
2. To begin preliminary analyses of larch sawfly population and mortality data to determine the relationships between population trends and the biological and physical components of the environment.

3. Particular attention will be given to determining the role of the three aforementioned parasites in population regulation.

## 20. Signature(s):



W.G.H. Ives  
Investigator



J.A. Muldrew  
Investigator

March, 1971

REDUCTION OF LOSSES FROM WOOD DECAY

The extent of decay in commercial forests vary with their age, composition and site. Decay is a natural phenomena and in most instances becomes economically disruptive only in the over mature stands. Management agencies under these circumstances require only indices which will permit them to assess the degree cull before logging commences. Methods for cull surveys are now known which will provide data adequately precise under present levels of utilization. Much basic informaton is lacking relating to entry and colonization of decay causing pathogens. Basic studies are underway on chemistry of decay in conifers and new information has been obtained on the mechanisms of decay resistance in the trees. The utilization of aspen is increasing in this region. Incidence of decay in aspen is, in many instances, very high rendering some non-commercial. Certain clones of aspen are known from our earlier work to have a resistance to decay. The possibility of identifying and utilizing some of these clones for propogation is being examined.

Investigators in this group play an active liaison and service role with management agencies which includes participation in task forces, assistance with cull surveys, assessments in the field of disease incidence in permanent plots and new re-generation.



Project Review Statement

Fiscal Year: 1971-72

1. Establishment: Prairies Region. Date Prepared: March 1971
2. Title: Fungal decay in trees.
3. Investigator: A.A. Loman
4. Year of Commencement: 1965
5. Estimated Year of Completion: Original 1969  
Revision I continuing
6. Key Words not in Title: Pinus contorta var. latifolia, phenolics, heartwood extractives, fungitoxicity, resistance, extracellular enzymes, heartwood fungi.
7. Discipline: Pathology.
8. Project Group: Reduction of losses from wood decay.
9. Estab. Proj. A 059 Service Project NOR 028
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 62. Other: 44.
12. Man-months utilized in fiscal year under review: Prof.: 12. Other: 6.
13. Man-month requirement in next fiscal year: Prof.: 12. Other: 12.
14. Location of work: Selected merchantable forest stands in Alberta. CFS Laboratory Edmonton, Alberta.
15. Background statement:
  - a - Project proposed by: Canadian Forestry Service
  - b - Objectives: To identify the factors which influence the processes of infection, establishment, and development of stain and decay fungi in the merchantable tree species in the Prairies Region.

c - Need for project: Losses of merchantable volumes due to defects including stain and decay, are high in unmanaged forests in the Prairies Region. It is anticipated that growing demands for forest products will increase the intensity and quality of forest management practices. An understanding of the factors which influence colonization of trees by stain and decay fungi is prerequisite to the formulation of sound management procedures. It is assumed that silvicultural practices aimed at reducing losses due to stain and decay fungi will become economically practical only in forests that will be harvested at pathological rotation age. The biological factors of stain and decay development will therefore be studied in immature trees rather than in overmature decadent trees.

d - Cooperating Agencies: Forest Management Agencies in Alberta, Saskatchewan and Manitoba: Provincial and Industrial.

16. Accomplishments to beginning of fiscal year under review:

Results of cull surveys and identification of fungi associated with stains and decays are summarized in seven reports and publications. Excessive decay is generally found in overmature stands only, and can therefore be eliminated by harvesting before merchantable stands reach pathological rotation ages. Recommended rotation ages are: lodgepole pine 100 years, white spruce 100 to 120 years, aspen 40 years, and balsam poplar 40 to 70 years.

Evidence of fungal successions culminating in advanced decay by Fomes pini was found in lodgepole pine. Four fungi predominated in a fungal flora comprising 30 species. In decreasing order of frequency of isolations, these fungi were Peniophora pseudo-pini (30%), Coryne sarcoides (24%), Tympanis hypopodia (15%) and Fomes pini (3%). The fungi were isolated from heartwood tissues which contain high concentrations of the fungitoxic phenolic compounds pinosylvin and its monomethyl ether. These compounds are restricted to the heartwood and are believed to be synthesized in slowly dying sapwood cells such as occur in sapwood-heartwood transformations, insect attack, fungal attack or mechanical injury to the cambium. Experiments were designed to examine the capabilities of the predominating heartwood fungi to synthesize enzyme systems which could catalyze the transformation of the fungal-inhibitory stilbenes pinosylvin and pinosylvinmonomethyl ether. Results showed that laccase-producing heartwood fungi transform the two stilbenes by two mechanisms. The ascomycetes Coryne sarcoides and Tympanis hypopodia transform the stilbenes via another phenolic substance, which absorbs at a shorter wavelength, and the basidiomycetes Peniophora pseudo-pini and Fomes pini probably remove the stilbenes in a process of polymerization, which causes red-staining of the natural substrate. One non-laccase producing test fungus, Coniophora puteana, detoxified pinosylvin in what are believed to be enzyme-inhibitor complexes. Bioassays on the traditional bioassay medium 2% malt extract agar (2% MEA) and on 2% MEA enriched to 10% heartwood meal revealed that tolerances to the inhibitory compounds were doubled for the white rot fungi and quadrupled for the brown rot fungus on bioassay media enriched with natural substrate.

Infrared spectroscopy was used as a tool for the differentiation of fungi in culture, with promising results. The instrument is designed to identify the functional groups of a pure compound. The infrared spectra of ether extracts from aqueous culture media have sharp well resolved absorption bands, even though the ether extract is a mixture of several compounds. Fungal species have specific enzyme complements. The working hypothesis is that substrate molecules will be transformed at different rates or by different pathways, by different fungal species.

17. Goals set for fiscal year under review:

Publication of parts of the Ph.D. thesis.

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

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

18. Accomplishments during fiscal year under review:

A satisfactory procedure was developed for the synthesis of pinosylvin, pinosylvinmonomethyl ether and five additional naturally occurring stilbenes. This work was published in the Canadian Journal of Chemistry.

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

Experiments to elucidate the biosynthesis of lodgepole pine heartwood flavanones and stilbenes were discontinued due to lack of qualified technical assistance and removal to Edmonton. Experimental work designed to simplify the preparatory steps to infrared spectroscopy of extracts from liquid fungal cultures was resumed in Edmonton. The time from inoculation to infrared spectrum has been reduced from 25 to 10 days.

Specific requests for relevant research results and experience were received by the Provincial Forest Management Branch, and resulted in the submission of the following reports:

Loman, A.A. 1970. Aerial Inventory and Cull Survey. Submitted to the Alberta Department of Lands and Forests.

Loman, A.A. 1970. The effect of clearcutting on infection and development of disease in regeneration in Alberta. Submitted to the Alberta Department of Lands and Forests.

## 19. Goals for next fiscal year:

Preparation of the following publications:

Differentiation of wood decay fungi by the infrared spectra of their ether extracts. Journal publication.

On the distribution of pinosylvin, pinosylvinmonomethyl ether, pinobanksin and pinocembrin, in the xylem tissues of Pinus contorta var. latifolia. Journal publication.

Continuation of experiments designed to refine techniques for infrared fingerprinting of cultures of wood decay fungi.

Maintenance of liaison and development work with Provincial and Industrial Agencies with regard to decay and cull problems in forest inventory and management.

## 20. Signature:



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A.A. Loman  
Investigator

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

1. Establishment: Prairies Region                      Date Prepared: March, 1971
2. Title:                                                      Decay of lodgepole pine  
logging slash.
3. Investigator:                                              A.A. Loman
4. Year of Commencement:                                      1952
5. Estimated Year of Completion:                              1969  
Revision 1971
6. Key Words not in Title:                                      Fungi, moisture, temperature,  
Pinus contorta var. latifolia.
7. Discipline:                                                      Pathology
8. Project Group:                                                      Reduction of slash fire  
hazard.
9. Estab. Proj.                                                      Service Project No. NOR 097
10. Status at time of statement  
preparation:                                                      Active
11. Estimated total man-months  
utilized to date:                                                      Prof.: 72    Other: 108.
12. Man-months utilized in fiscal  
year under review:                                                      Prof.: 2.    Other: none
13. Man-month requirements in next  
fiscal year:                                                      Prof.: none    Other: none
14. Location of Work:                                                      Strachan, Alberta.  
Edmonton Laboratory
15. Background Statement:
- a - Project proposed by: Canadian Forestry Service
- b - Objectives:                                                      1. To identify the fungi  
associated with lodgepole pine logging slash.
2. To determine which species  
of fungi were responsible for the deterioration of slash.

3. To discover a possible fungal succession in logging slash of increasing ages.

4. To study the effects of microclimatic factors in residual stands created by different cutting methods and size and position of individual pieces of slash in relation to the ground, on fungus distribution and fungus activity.

c - Need for project: Logging slash of lodgepole pine may create serious fire hazards and regeneration problems. Although lodgepole pine logging slash is known to deteriorate slowly, little is known of the effect of environmental conditions created by different cutting methods on rates of deterioration of slash and of the fungi involved.

d - Co-operating Agencies: a. Alberta Department of Lands and Forests. This agency provided 160 acres for research purposes as well as facilities to carry out field work.

b. Department of Agriculture, Plant Research Institute. This agency assisted in the identification of fungal cultures.

16. Accomplishments to beginning of fiscal year under review:

Eighty-one identified species of fungi were collected from the bark, twigs, needles and wood, <sup>89</sup>sporophores or as cultural isolates from stained and decayed wood of lodgepole pine logging slash. Only four of these were consistently and significantly associated with fungal decay. The distribution of the four active slash decayers was related to their high-temperature tolerance or intolerance and to their temperature optima for development. High-temperature tolerating Peniophora phlebioides Jacks. and Dearden was found to predominate near the upper exposed portions of individual pieces of slash, Lenzites saepiaria Wulf. ex Fr. predominated in central portions and high-temperature intolerant Coniophora puteana Schum, ex Fr. and Stereum sanguinolentum Alb. and Schw. ex Fr. were restricted to areas near the sheltered undersides of individual pieces of slash.

Deterioration of slash commenced with a browning and casting of needles within 2 to 5 years after logging, while bark sloughed off the exposed portions of the stems within 5 to 10 years. The process of fungal decay was associated with case hardening of the outer growth rings of the stems which resulted in hard cylindrical shells encasing cores in various stages of decay. Slash form changed very little over the years and it is probable that the fire hazard remains high in untreated slash for many years after cutting despite activities of decay organisms. The following reports and publications have been made:

Two scientific publications in the Canadian Journal of Botany

One interim report.

Three reports in the Proceedings of the Western International Forest Disease Work Conference and the Canadian Phytopathological Society.

The results of the slash decay studies satisfy the original objectives.

17. Goals set for fiscal year under review:

Completion of the project

with the following publications:

1. Loman, A.A. Fungi associated with logging residues of Pinus contorta Dougl. var latifolia Engelm. Proposed journal publication.
2. Loman, A.A. Physical aspects of lodgepole pine slash deterioration. Proposed departmental publication.

18. Accomplishments during fiscal year under review:

Little has been accomplished

in this project since April 1970.

19. Goals for next fiscal year:

The project will be terminated

upon publication of the two manuscripts listed under item 17.

20. Signature:



\_\_\_\_\_  
A.A. Loman  
Investigator

March, 1971

REDUCTION OF LOSSES FROM STEM DISEASES

Lodgepole pine, Jack pine and aspen are important species of commercial and aesthetic value in this region. All are subject in varying degrees to stem infestation, in some instance of sufficient magnitude to cause losses by degrade or death; mistletoe on the pines, and cankers on both pines and aspen. The nature of the organisms causing these diseased conditions lend themselves more than most to control by silviculture or cultural means. Our studies on mistletoe and cankers have that objective. A great deal is known of these pathogens. Members of the research group spend considerable time assessing and advising on these pathogens and their control with management agencies and the general public. Research programs deal principally with identification of the pathogens, their courts of entry, colonization of the host, and early detection of symptoms on the host.



PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

- |     |                                                     |                                                                                                                                                                                                           |
|-----|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.  | Establishment: Prairies Region.                     | Date Prepared: March, 1971.                                                                                                                                                                               |
| 2.  | Title:                                              | Forest tree rusts of western North America.                                                                                                                                                               |
| 3.  | Investigator:                                       | Y. Hiratsuka.                                                                                                                                                                                             |
| 4.  | Year of Commencement:                               | Project A-232 (1961) and A-254 (1965) were combined and redesigned in 1968.                                                                                                                               |
| 5.  | Estimated Year of Completion:                       | Original: Indefinite.<br>Revision I: 1978.                                                                                                                                                                |
| 6.  | Key Words not in Title:                             | <u>Cronartium</u> , <u>Pucciniastrum</u> ,<br><u>Peridermium</u> , <u>Melampsora</u> ,<br><u>Chrysomyxa</u> , cytology,<br>morphology, taxonomy,<br>Uredinales, inoculation<br>experiment, pathogenicity. |
| 7.  | Discipline:                                         | Pathology.                                                                                                                                                                                                |
| 8.  | Project Group:                                      | Detection and appraisal of<br>tree pest damage.                                                                                                                                                           |
| 9.  | Estab. Proj.     A 057                              | Service Project: NOR 026                                                                                                                                                                                  |
| 10. | Status at Time of Statement<br>Preparation:         | Active.                                                                                                                                                                                                   |
| 11. | Estimated total Man-Months<br>Utilized to Date:     | Prof.: 59     Other: 45                                                                                                                                                                                   |
| 12. | Man-Months Utilized in Fiscal<br>Year Under Review: | Prof.: 10     Other: 11                                                                                                                                                                                   |
| 13. | Man-Month Requirements in Next<br>Fiscal Year:      | Prof.: 10     Other: 11                                                                                                                                                                                   |
| 14. | Location of Work:                                   | Edmonton (laboratory, greenhouse<br>and mycological herbarium),<br>Kananaskis Forest Experiment<br>Station, Western North America<br>with particular emphasis in<br>Prairie Region (field).               |

## 15. Background Statement:

a - Project proposed by: Canadian Forestry Service.

b - Objectives: General: To acquire a comprehensive knowledge of the forest tree rusts of western North America with particular emphasis on the Prairie Region in terms of identity, host range, life history, distribution and pathogenicity.

Specific: To study aspects of cytology, taxonomy, life history and host-parasite relationship of conifer needle rusts, pine stem rusts, and populus-conifer rusts of the region and related species in the world.

c - Need for Project: Rust fungi are known to attack vigorously growing plants rather than weakened ones because of their obligate parasitism. Damage caused by this group of fungi tend to be increased by intensive cultural practices as evidenced by such cases as, white pine blister rust in North America, poplar rusts in Europe, comandra blister rust of hard pines in south-eastern North America, and wheat stem rusts and coffee rust in many parts of the world.

An estimate of the losses attributable to forest tree rusts in the region has not been obtained but significant growth loss and mortality of several major forest tree species, including lodgepole pine, jack pine, white spruce, black spruce, balsam fir and subalpine fir, have been suggested. In addition, several rust species endemic to the region have been recognized as serious pathogens in other areas where forestry practices are more intensive.

Our knowledge of western forest tree rusts has been inadequate to solve present and future problems which are and will be caused by this group of fungi and studies of this group of fungi on identity, life history, host range, cytology, morphology, distribution and pathogenicity are necessary.

d - Co-operating Agencies: Forest Insect and Disease Survey organizations across Canada (for distribution data and samples). Mycological Herbarium, Plant Research Institute, Ottawa (consultations and specimen examination). Several foreign institutions (exchange of specimens). Scanning Electron Microscope Center, Dept. of Civil Engineering, University of Calgary (scanning electronmicroscope). Department of Microbiology, University of Alberta (transmission electronmicroscope).

## 16. Accomplishments to Beginning of Fiscal Year Under Review:

1. Comparative studies of the nuclear phenomena of the aeciospores and germinating aeciospores of P. harknessii and P. stalactiforme have been completed and published. Further nuclear studies have been carried out with the aeciospores of P. harknessii material from other regions and preliminary nuclear studies of other North American stem rusts have been done.

2. Studies on temperature and pH requirements for an orange and white spored aeciospore germination of P. harknessii and P. stalactiforme have been completed and published.

3. White spored P. stalactiforme (Cronartium coleosporioides f. album) was discovered in 1960 in a small area in Banff National Park and annual observations were commenced in 1963. Occurrence of this form and the results of the annual observations of canker growth and tree mortality up to 1965 were published in 1966. Annual surveys of the white spored form and the typical yellow spored form in the area were continued.

4. A study trip to northern Europe (Norway, Sweden, Netherlands, Scotland) was conducted during May and June of 1967 to study germ tube cytology of host alternating and pine-to-pine races of Cronartium flaccidum (Peridermium pini). About 300 fixed slides of germinating spores have been prepared and brought back for cytological studies. Significant differences between the two races were found and the results have been published.

5. Study of aeciospore germ tubes of pine gall rust from Quebec and New Brunswick showed clearly that they are Peridermium harknessii rather than Cronartium quercuum as previously reported. A note has been published.

6. Study of aeciospore germ tubes of Peridermium ephedrae from New Mexico indicated an unusual nuclear cycle and a note has been published.

7. Pucciniastrum vaccinii complex: Inoculation experiments and preliminary morphological comparisons have been completed.

8. Yellow-spored Peridermia on Abies: Morphological comparisons and literature survey have been completed and compilation of results for publication has been started.

## 9. Spruce needle rusts:

Several inoculation experiments have been done. Inoculation of Pucciniastrum sparsum from Artostaphylos rubra to Picea glauca was successful. This presents the first record of this rust on Picea in North America and the results have been published.

## 17. Goals set for Fiscal Year under Review:

1. Complete taxonomic revision of the autoecious pine stem rusts including the proposal of a new genus Endocronartium.

2. Continue detailed cytological study of Peridermium pini and P. harknessii and other pine stem rusts.

3. Complete the taxonomic and life history studies of Pucciniastrum sparsum and P. geoppertianum.

4. Start the survey and basic study of Cronartium ribicola in the region.

5. Continue survey of white and orange spored Cronartium coleosporioides in Banff National Park.

6. Continue inoculation experiments and morphological studies of several conifer needle rusts.

## 18. Accomplishments During Fiscal Year under Review:

a. Taxonomic revision of pine stem rusts, including the establishment of a new genus for autoecious species, is completed and results have been published.

b. Morphology and life history study of a spruce needle rust, Pucciniastrum sparsum, have been completed and the results have been published.

c. Morphological study of forest tree rusts by scanning electron microscope is in progress and significant results have been obtained. Two papers on the subject have been published.

## Publications:

- Hiratsuka, Y. 1969. Endocronartium, a new genus for autoecious pine stem rusts. *Can. J. Bot.* 47, 1493-1495.
- Powell, J.M. and Hiratsuka, Y. 1969. Nuclear condition and germination characteristics of the aeciospores of Cronartium comandrae and C. comptoniae. *Can. J. Bot.* 47, 1961-1963.
- Hiratsuka, Y. 1970. Identification and morphology of the aecial state of Pucciniastrum sparsum in northwestern Canada. *Can. J. Bot.* 48, 433-435.
- Hiratsuka, Y. 1970. Emergence of the aeciospore germ tube of Cronartium coleosporioides (Peridermium stalactiforme) as observed by scanning electronmicroscope. *Can. J. Bot.* 48, 1692.
- Hiratsuka, Y. Spore surface morphology of pine stem rusts of Canada observed by a scanning electronmicroscope. *Can. J. Bot.* (In press).
- Krebill, R.G. and Hiratsuka, Y. Possible life cycle and nuclear condition of Peridermium ephedrae. *Southwestern Naturalist* (In press).

## Reports:

- Hiratsuka, Y. and Powell, J.M. Cytology and taxonomy of autoecious pine stem rusts. International Botanical Congress at University of Washington, Seattle, August, 1969.
- Hiratsuka, Y. Scanning electron microscope as applied to the studies of forest fungi. Canadian Phytopathological Society, Alberta Regional Meeting. Kananaskis, Nov. 1969.

## 19. Goals for the next Fiscal Year:

- a. Continue comparative morphological studies of pine stem rusts and other forest tree rusts by scanning electron microscope and transmission electron microscope.
- b. Start greenhouse inoculation experiments of pine stem rusts to study host penetration, disease establishment and symptom development. Special emphasis will be on the gall formation by Endocronartium harknessii.

c. Plan and start experiments to study interruption of water translocation by different pine stem rusts. Nontoxic dye (such as highly diluted acid fuchsin) will be used for the study. Histology of cankers will be studied in connection with the water translocation.

d. Continue life history and taxonomic studies of several spruce and fir needle rusts.

e. Continue survey of Cronartium coleosporioides f. album in Banff National Park.

f. Complete morphological and cytological study of Gymnosporangium gaeumannii ssp. albertensis.

Proposed publications:

Pine stem rusts of Canada (with J.M. Powell, Proposed for departmental publication series).

Morphology and cytology of Gymnosporangium gaeumannii ssp. albertensis. (proposed for Mycologia).

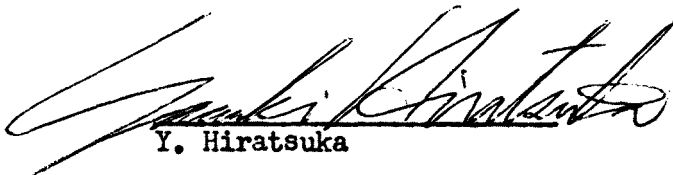
Cytology, taxonomy and nomenclature of autoecious pine stem rusts from Europe and North America (Proposed for Trans. Japanese Mycol. Soc.).

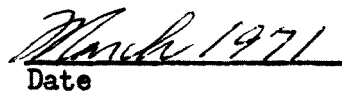
Proposed reports:

Morphology and cytology of Gymnosporangium gaeumannii ssp. albertensis. Paper to be presented at the Annual Meeting of Mycological Society of America (CBA-AIBS Joint Meeting), University of Alberta, Edmonton, June, 1971.

Morphology of forest tree rusts spores observed by a scanning electron microscope. A display proposed for the First International Mycological Congress, University of Exeter, Devon, England, Sept. 1971.

20. Signatures:

  
Y. Hiratsuka

  
Date

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Biology and epidemiology of dwarf mistletoe on lodgepole pine.
3. Investigator: J. Muir.
4. Year of Commencement: 1962.
5. Estimated Year of Completion: Original 1973.
6. Key Words not in Title: Arceuthobium americanus, Pinus contorta, parasites, dissemination, germination, SAI, B19.
7. Discipline: Pathology.
8. Project Group: Reduction of losses from dwarf mistletoe.
9. Estab. Proj. No. A 062 Service Project No. NOR 029
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 36. Other: 36.
12. Man-months utilized in fiscal year under review: Prof.: 0. Other: 12.
13. Man-month requirements in next fiscal year: Prof.: 0. Other: 12.
14. Location of Work: Calgary, Kananaskis, Forest Experimental Station, forested areas of southern Alberta.
15. Background Statement:
  - a - Project proposed by: Canadian Forestry Service.
  - b - Objectives: Record and describe normal intensification in young lodgepole stands, determine the effects of environmental

factors on time, frequency and distance of seed dissemination; determine effect of environmental factors on growth, flowering and seed production; determine influence of hyperparasitism on dwarf mistletoe.

c - Need for project: In the Alberta region, surveys indicate 10 percent of lodgepole pine and jack pine are infected by dwarf mistletoe. Cumulative losses of up to 34 percent have been recorded in severely infected stands. Silviculture control studies are in progress at this laboratory (A063) and elsewhere. Information important to refinement of present control methods is lacking in areas of mistletoe epidemiology and parasitism.

d - Co-operating Agencies:                   None.

16. Accomplishments to beginning of fiscal year under review:  
 Preliminary analysis of data from a number of mistletoe infected stands indicate intensification tends to increase at a uniform rate, and no large differences in rate occurred between stands despite wide differences in inoculum source, stand density, exposure, soil moisture. Rates of Intensification have been mathematically described. Ninety percent of seed dissemination occurred within a few days in late August, and variations in amount of seed dispersed were not correlated with any meteorological factors.

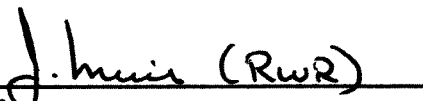
It was observed approximately 8 percent of the dwarf mistletoe seed naturally deposited, or inoculated on trees, in September, 1966, has caused visible infections by September 1968. Seed dissemination observations were continued, and considerable variation was observed between separate areas. Distance of spread averaged 28 ft. from uniform margins of infected stands and 45 ft. from single residual trees. Three interim reports are in preparation, together with one publication for scientific journal.

17. Goals set for fiscal year under review:
1. Summarize data from intensification study.
  2. Continue observations of seed dispersal from infected trees and individual dwarf mistletoe plants.
  3. Continue field inoculations and observations on naturally dispersed seed and development of infection in growth chambers and greenhouse.

18. Accomplishments during fiscal year under review:  
 Additional observations were made in the field on incubation and latent periods of mistletoe infection. This investigation has been on educational leave during the past two years.



19. Goals for next fiscal year:
1. Continue to monitor field plots.
  2. Complete education commitments.
20. Signature:

  
J. Muir,  
Investigator. March, 1971.

PROJECT REVIEW STATEMENTFiscal Year 1971-1972

- |                                                               |              |                                                                                                                                               |                   |
|---------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1. Establishment:                                             | B.C. Region. | Date Prepared:                                                                                                                                | March, 1971.      |
| 2. Title:                                                     |              | Silvicultural control of dwarf mistletoe in young lodgepole pine stands.                                                                      |                   |
| 3. Investigator:                                              |              | J.A. Baranyay.                                                                                                                                |                   |
| 4. Year of Commencement:                                      |              | 1967.                                                                                                                                         |                   |
| 5. Estimated Year of Completion:                              |              | Original 1989.                                                                                                                                |                   |
| 6. Key Words not in Title:                                    |              | <u>Arceuthobium americanum</u> , <u>Pinus contorta</u> , cleaning, disease intensification, tree growth, Alberta, British Columbia, SA 1, M2. |                   |
| 7. Discipline:                                                |              | Pathology.                                                                                                                                    |                   |
| 8. Project Group:                                             |              | Reduction of losses from stem diseases.                                                                                                       |                   |
| 9. Establ. Proj. No.:                                         | A 063        | Service Proj. No.:                                                                                                                            | BC 085<br>NOR 030 |
| 10. Status at time of statement preparation:                  |              | Active.                                                                                                                                       |                   |
| 11. Estimated total man-months utilized to date:              |              | Prof.:                                                                                                                                        | 3 Other: 14       |
| 12. Man-months requirements in next fiscal year:              |              | Prof.:                                                                                                                                        | 2 Other: 2        |
| 13. Man-month requirements in next fiscal year:               |              | Prof.:                                                                                                                                        | 1 Other: 1        |
| 13a. Estimated man-month requirement to complete the project: |              | Prof.:                                                                                                                                        | 10 Other: 26      |
| 14. Location of Work:                                         |              | Southern Alberta foothills, Interior B.C.                                                                                                     |                   |
| 15. Background Statement:                                     |              |                                                                                                                                               |                   |
| a. Project proposed by:                                       |              | Canadian Forestry Service.                                                                                                                    |                   |

b. Objectives: The principal objective is to obtain guidelines relating to silvicultural management of mistletoe infected pine stands. Interim objectives are: (1) to test the effectiveness of different thinning methods to control dwarf mistletoe; (2) to study disease intensification and tree growth relationships in treated and untreated stands.

c. Need for project: Dwarf mistletoe has been reported to damage lodgepole pine of all age classes by causing mortality or loss in vigor, growth and quality. Hawksworth (1958) found that infected stands in Colorado and Wyoming, yielded 3,700 board feet per acre less than the healthy stands. Baranyay and Safranyik (1970) in Alberta measured growth losses of 18.1 to 31.5 per cent in five stands ranging in age from 37 to 117 years. Losses of this magnitude justify control, and at present, silvicultural methods are the most promising.

d. Co-operating Agencies: Prairie Region (execution of work); U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado (planning of work); Provincial Forest Service of Alberta and of B.C. (reserve study areas).

16. Accomplishments to beginning of fiscal year under review: In a co-operative study between the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado; British Columbia Region, Victoria; and Prairie Region, Edmonton, a total of 23 half-acre sample plots were established in Alberta and B.C. in 1967 and 1968. A set of five plots constituted a sample which contained the following treatments or conditions: (a) infected control untreated; (b) healthy control untreated; (c) healthy cleaned; (d) infected cleaned; and (e) dwarf mistletoe eradicated. On each plot two sub-plots (0.025 acres) were established near opposite corners, where each tree was tagged to provide intensive sampling for disease intensification and tree growth data. The following sampling areas were established; ten sample plots in a 27-year-old lodgepole pine stand in the Etherington Creek and Cataract Creek area, Bow River Forest, Alberta, five sample plots in a 23-year-old stand in the Dutch Creek area, Crowsnest Forest, Alberta and five and three sample plots in the Beaverdam Lake and Tin Cup Lake area, respectively, in a 29-year-old lodgepole pine stand of the Kamloops Forest District in B.C. The rate of infection on these plots varied from 25 to 75 per cent.

17. Goals set for fiscal year under review: With the aid of the Prairie Region's damage appraisal crew, re-survey and treat the ten sample plots in the Bow Forest in Alberta.

18. Accomplishments during fiscal year under review: The ten sample plots in the Bow Forest in Alberta were re-treated after a 3-year period. An average of 15 per cent (range 13-21) of the trees left after the first treatment were visibly infected and treated. Originally, the average disease intensity

was 30 per cent (range 15-41) in these plots. It was learned during the survey that one of the control plots were destroyed by a thinning crew supervised by Alberta Forest Service personnel.

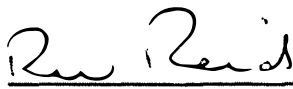
Six one-day workshops were conducted throughout the Province to discuss up-to-date research results on the distribution, biology, impact and control of dwarf mistletoe. The response from outside participants in the workshop suggested this approach provides an effective medium for disseminating research results (Int. Rept. BC-23).

#### Recent reports

Smith, R.B. and J.A. Baranyay. 1970. Dwarf mistletoe in British Columbia, Can. Forest. Serv., For. Res. Lab., Victoria. Misc. Rept., 8 p.

Baranyay, J.A. and R.B. Smith. 1970. Dwarf mistletoe workshops planning and execution. Can. Forest. Serv., For. Res. Lab., Victoria, Int. Rept. BC-23, 30 p.

19. Goals for next fiscal year: Re-survey and treat the 5 sample plots in the Dutch Creek area, Crowsnest Forest, Alberta. Locate and survey a control plot to replace the destroyed one in the Highwood area. The Prairie Region's damage appraisal crew will aid in this work. Re-survey and treat the 8 sample plots in the Kamloops Forest District in B.C. With the completion of this work all the plots will have been re-surveyed and re-treated once since establishment. The initial results will be summarized in an Internal Report.
20. Signatures:

for   
 J.A. Baranyay,  
 Investigator.

March, 1971.



causes infection to appear at the base of the stem. Later infections occur in the upper stem and crown. On maturing trees the bark becomes dark grey and furrowed into thick ridges throughout the entire trunk and main branches. All clones are susceptible with few exceptions.

d - Co-operating Agencies: Staff in two Mycological Institutes in Canada and in Europe examined and compared collections to verify if R. moriformis was a new fungus.

16. Accomplishments to beginning of fiscal year under review:

Rhytidiella moriformis, occurring on balsam poplar (Populus balsamifera) in Manitoba, Saskatchewan, and British Columbia produces pycnidia with two types of conidia. Phaeoseptoria and Phyllosticta both of which predominate on one to five-year-old infections. In older bark the perithecial production predominates persistently for about 65 years. Zalasky, H. 1968. Rhytidiella moriformis n. gen., n. sp. causing rough-bark of Populus balsamifera. Can. J. Botany 46, 1383-1387.

The disease, rough-bark of balsam poplar, as well as the perfect and the imperfect states of R. moriformis were described in the above publication. Cross-inoculations in the greenhouse showed that the fungus from balsam poplar infects aspen and balsam poplar but the aspen isolates inoculated into balsam poplar produced inconclusive results. Investigation of the total phenols and sugars extracted from balsam poplar bark indicates that the pathogen and two succession fungi are capable of utilizing both substances in liquid cultures.

Test plants of hybrid poplar were also successfully infected in the greenhouse. Histological studies of infected material showed conclusively that the fungus causes hypertrophy of the periderm and rough-bark.

The succession fungus Galiciopsis calicioides is now known to occur on cottonwood (P. deltoides), black cottonwood, balsam poplar, and poplar shade trees of hybrid origin in Alberta, Manitoba, Saskatchewan and eastern and western United States.

17. Goals set for fiscal year under review:

Complete histological investigation on pathogenicity and begin preparation of manuscript.

18. Accomplishments during fiscal year under review:

Specimens of the fungus R. moriformis have been deposited in various major herbaria in Canada, United States and Europe for study and reference. Prepared morphological data and photographed the Perfect and Imperfect States of other species of Rhytidiella collected earlier. Prepared semi-permanent slides of greenhouse inoculated poplar material for detailed histological study.

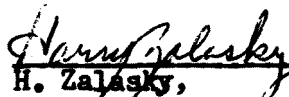
Zalasky, H., Nawawi, A., Ting, W.P. and L.H. Tai. 1971.  
Dolabra nepheliae and its imperfect state associated  
with canker of Nephelium lappaceum and N. mutabile.  
Can. J. Botany. April. (in press)

19. Goals for next fiscal year:

Proposed publication:

Zalasky, H. Histology of host-parasite relationships of Rhytidiella moriformis. Zalasky on poplar bark.

20. Signature(s):

  
\_\_\_\_\_  
H. Zalasky,  
Investigator.

March 1971

PROJECT REVIEW STATEMENTFiscal Year: 1971-1972

- |                                                      |                         |                                                                                                                                                                         |              |
|------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1. Establishment:                                    | Edmonton, Alberta.      | Date prepared:                                                                                                                                                          | March, 1971. |
| 2. Title:                                            |                         | Reduction of losses from Canker and dieback.                                                                                                                            |              |
| 3. Investigator:                                     |                         | H. Zalasky.                                                                                                                                                             |              |
| 4. Year of Commencement:                             |                         | 1965.                                                                                                                                                                   |              |
| 5. Estimated Year of Completion:                     |                         | Original 1975.<br>Research 1973.<br>Demonstration 1975.                                                                                                                 |              |
| 6. Key Words not in Title:                           |                         | Aigeiros, Tacamahaca, hybrids, Leuce, poplar and disease resistance, <u>Mycosphaerella</u> , <u>Diplodia tumefaciens</u> , <u>Septoria</u> , <u>Salix</u> , Frost ring. |              |
| 7. Discipline:                                       |                         | Pathology.                                                                                                                                                              |              |
| 8. Project Group:                                    |                         | Reduction of losses from stem diseases.                                                                                                                                 |              |
| 9. Estab. Proj. No.:                                 | MS 003                  | Service Proj. No.:                                                                                                                                                      | NOR 044.     |
| 10. Status at time of statement preparation:         |                         | Active.                                                                                                                                                                 |              |
| 11. Estimated total man-months utilized to date:     |                         | Prof.:                                                                                                                                                                  | 24 Other: 30 |
| 12. Man-months utilized in fiscal year under review: |                         | Prof.:                                                                                                                                                                  | 7 Other: 6   |
| 13. Man-month requirements in next fiscal year:      |                         | Prof.:                                                                                                                                                                  | 8 Other: 7   |
| 14. Location of Work:                                |                         | Regionwide seed collecting and observation of cankers in plantations.                                                                                                   |              |
| 15. Background Statement:                            |                         |                                                                                                                                                                         |              |
|                                                      | a. Project proposed by: | Canadian Forestry Service.                                                                                                                                              |              |



- b. Objectives:
1. To study variability of hardiness of poplar to physiologic canker and dieback for each clone under field conditions;
  2. To conduct field and greenhouse inoculation trials with Diplodia tumefaciens and Septoria spp.;
  3. To describe Mycosphaerella spp. on Salicaceae in this region;
  4. To elucidate the life history of new species of Mycosphaerella and the pathogenicity of Septoria musiva Pk. and Septoria populicola Thompson;
  5. To review and critically examine taxonomy and distribution of Mycosphaerella in our region; and
  6. To provide advisory services to outside agencies on establishment and maintenance of planted poplars.

c. Need for project: Poplar clones planted under certain conditions in the agricultural or boreal zone may have marginal survival and growth capability as well as being susceptible to canker and dieback. It is therefore important to investigate the underlying cause of the important disease in this region. Exacting temperature requirements of the clones do not permit a complete production of summerwood that would be resistant to injury by insects, fungi and severe winter conditions. The close association of this disease with cultural practices and weather may require relating both factors to its incidence. Septoria organism is not responsible for the perennial nature of the canker either initially or at a later stage of development.

Septoria, an Imperfect State of some of the species of Mycosphaerella on poplar is economically important as a causal agent of canker of whips in the nursery. Recently some pathologists unsuccessfully investigated morphological variation of Septoria musiva with the objective of clarifying differences in pathogenicity and symptomatology in poplars. Morphological variation is reported to occur in some species of Mycosphaerella, a subject of the present investigation both mycologically and pathologically.

d. Co-operating Agencies: Provincial Nursery at Hadashville, Manitoba and P.F.R.A. Tree Nursery at Indian Head, Saskatchewan, provided test plots and progeny material for study. Universities, Botanical and Research Institutes, Herbaria in Canada, U.S.A., Europe, and Argentina provided herbarium and type specimens to research. Tree Advisory Committee, Edmonton to execute changes in cultural practices.

16. Accomplishments to beginning of fiscal year under review: Seeds from 90 families of P. balsamifera and 60 of P. deltoides var. occidentalis were collected for susceptibility tests in the greenhouse during 1968 to 1970. For taxonomic studies, all Exsiccati, type specimens and of Mycosphaerella on poplar were examined and annotated from prepared microscope slides. Color and black and white photographs were prepared. Over 200 specimens of three species of Mycosphaerella were collected in Alberta, Manitoba and Saskatchewan for taxonomic description. Investigated in the field and laboratory, perennial cankers resulting from injuries frequently mistaken for septoria canker.
17. Goals set for fiscal year under review: Continue to inoculate poplar maintained in the field and greenhouse. Goal discontinued in 1970 because of transfer, and changes in direction of septoria canker research. Investigate variability in resistance of poplars and other hardwoods to canker and dieback of non-fungal origin. Make more extensive collections of Mycosphaerellas on willow and some additional collections on poplar.
18. Accomplishments during fiscal year under review: Completed notes on resulting stem infections caused by S. musiva and D. tumefaciens at Birds Hill during 1968 inocuations. Completed testing of progeny of families of P. balsamifera and P. deltoides var. occidentalis for susceptibility to canker caused by isolates of S. musiva obtained from single spores of morphologically different ascospores of Mycosphaerella populorum. Completed an investigation of the life history and morphological forms within four species of Mycosphaerella occurring on poplar and several species on willow in our region. Three species occurring on willow were found to be new to science; two of these species were of economic importance. Over 200 specimens of Mycosphaerellas on willow and poplar from Manitoba and Saskatchewan were examined and prepared for mycological reference. Other specimens and Exsiccati on loan from other herbaria were also examined and annotated; misidentified specimens on willow collected in the Canadian arctic yielded three undescribed species of Mycosphaerella. Color slides and figures for many of these were made.

Advised private and District Agricultural Representatives on early identity and prevention of perennial target canker caused by frost ring injury in poplar and on remedial measure for severe cultivation damage resulting in sudden loss of vigor, wilting and rapid desiccation of poplar trees in valuable shelterbelts located in three areas of Alberta.

Discussed with nurserymen and suggested ways of controlling septoria canker in whips and loss of vigor in nursery stooling beds at Indian Head, Saskatchewan, Oliver, Brooks and Lacombe nurseries, Alberta. Visited parts supervisors in several Provincial Parks in Alberta at the request of Provincial Parks superintendent Mrs. Schultz to investigate and advise on the problem of cankering and rapid decline of young and mature trees.

Zalasky, H. 1970. Disease problems of poplar in the Western interior of Canada. Information Report A-X-39.

Zalasky, H. et al. 1968. Reactions of poplars to infection by Septoria musiva and Diplodia tumefaciens and to injury by frost in Manitoba and Saskatchewan.. Plant Disease Reporter 52, 829-833.

Zalasky, H. 1968. Plantation problems in Manitoba and Saskatchewan. Mimeo Rpt.

Zalasky, H. Reaction of Populus balsamifera and P. deltoides var. occidentalis to septoria canker under greenhouse conditions. Typewritten manuscript.

19. Goals for next fiscal year: Investigate frost ring in relation to canker and dieback incidence in conifers and hardwoods, and prepare a technical report. Five hundred cuttings of 5 clones of hybrid poplar planted at Oliver Tree Nursery for rooting and production of 1-year-old stock will be transplanted for two demonstration trials: (1) to show how to reduce and prevent loss from frost ring resulting in canker and dieback under plantation conditions. (2) To show how to prevent dieback and loss of vigor as well as prolong the life span and productivity of stooling stock in the nursery.

Maintain advisory services to outside agencies on problems pertaining to planted poplars.

Planned Reports, Publications and Demonstrations:

Zalasky, H. Frost ring resulting in a destructive canker and dieback of poplar.


Zalasky, H. Stem infections in native and hybrid poplar caused by Septoria musiva and S. populicola.

Zalasky, H. Demonstration of frost ring in aspen and hybrid poplar and how to prevent it.

Zalasky, H. Demonstration of an improved method of extending the life expectancy of stooling stock of poplar.

Zalasky, H. Species of Mycosphaerella and their imperfect states on poplar and willow.

20. Signature:

  
 H. Zalasky,  
 Investigator.

March, 1971

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-72

- |                                                         |                 |                                                                                                                 |              |
|---------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------|--------------|
| 1. Establishment:                                       | Prairies Region | Date Prepared:                                                                                                  | March, 1971  |
| 2. Title:                                               |                 | Cinder gall of poplar                                                                                           |              |
| 3. Investigator:                                        |                 | H. Zalasky                                                                                                      |              |
| 4. Year of Commencement:                                |                 | 1967                                                                                                            |              |
| 5. Estimated Year of Completion:                        |                 | Original                                                                                                        | 1971         |
| 6. Key Words not in Title:                              |                 | <u>Diplodia tumefaciens</u><br>fungi and succession,<br><u>Populus tremuloides</u> ,<br><u>P. balsamifera</u> . |              |
| 7. Discipline:                                          |                 | Pathology                                                                                                       |              |
| 8. Project Group:                                       |                 | Reduction of losses from<br>stem diseases.                                                                      |              |
| 9. Estab. Proj.                                         | MS 073          | Service Project No.                                                                                             | NOR 070      |
| 10. Status at time of statement<br>preparation:         |                 | Active                                                                                                          |              |
| 11. Estimated total man-months<br>utilized to date:     |                 | Prof.:                                                                                                          | 4. Other: 3. |
| 12. Man-months utilized in fiscal<br>year under review: |                 | Prof.:                                                                                                          | 1. Other: 3. |
| 13. Man-month requirements in next<br>fiscal year:      |                 | Prof.:                                                                                                          | 2. Other: 3. |
| 14. Location of Work:                                   |                 | Regionwide                                                                                                      |              |
| 15. Background Statement:                               |                 |                                                                                                                 |              |

a - Project proposed by: Canadian Forestry Service

b - Objectives: The objectives are to study successions and life histories of the parasites occurring in the bark tumors and in healed and unhealed branch stubs, to isolate and compare fungi from the branch stub with the fungi parasitic in the bark.

c - Need for project: This project is a continuation of PP-34a concerning the gall and rough-bark disease caused by Diplodia tumefaciens common on Populus tremuloides and P. balsamifera. The cinder gall occurs regionwide on particular clones of the species of poplar with poorly healed branch stubs and with bud gall mite injury. Severe damage occurs to the main trunk of all mature trees within a clone as a result of cankering of the centre portions of the gall by succession fungi or a syndrome of organisms.

In earlier research on the infection process of the branch stub preliminary to decay by primary fungi, it was found that Cytospora, Phoma and Libertella are presumably most important preliminary fungi. These fungi either provide stimulus and/or change the substrate (heartwood) sufficiently for the decay fungi that follow in the succession (Basham 1958 and Ethridge 1961). The common decadent areas are the branch stub and bud gall around which the bark forms a part of the tumorous healing tissue. Adjacent wood is frequently subject to decay and soft rot.

d - Co-operating Agencies: National and Provincial Parks provided research material for study.

16. Accomplishments to beginning of fiscal year under review:

The early disease symptoms are the same as those known for the gall and rough-bark of balsam poplar and aspen. One of the primary causal agents of the cinder gall is D. tumefaciens, the mycelia of which are perennial in the living cortex of the infected bark at the top and base of the gall. One other fungus is a species of Hendersonia presumed to be less important; it is also common on smaller swellings with no cinder-like bark. Succession fungi kill and degrade all of the tissues of the bark within the swellings. Some of the succession fungi are under investigation from material that was collected in several known localities in Manitoba. Presumably one or all of the succession fungi degrade the tissues of the bark within the mid-portion of the gall. The most frequent fungi in this association are Phomopsis, Cladosporium, Steganosporium, Fenestella and an ascomycete not as yet familiar to me. A red-colored hyphomycete is often isolated from the heartwood.

17. Goals set for fiscal year under review:

Obtain more information on the development of the disease in nature and the type of succession fungi found to be associated with the disease. Provide information to the Disease Survey personnel for work on geographic distribution and the amount of damage caused.

18. Accomplishments during fiscal year under review:

Progress to date: Objective (1) and (2) have been completed. Cinder gall is initiated by bud gall-mite and repeated attacks by the flat-headed borers in association with the fungus Diplodia tumefaciens. They are common on clones of aspen and balsam poplar that are highly susceptible to the organisms. Severe damage occurs to the main trunk, both basal and upper parts.

Branch clustering occurs on balsam poplar stems as a result of the infection.

Bud gall mite also follows D. tumefaciens infections but the resulting gall does not have the cinder-like characteristics. Similar galls on main stems result when D. tumefaciens establishes in the wood of dead branch stubs and stimulates, adjacent to it, excessive healing tissue of wood and bark.

19. Goals for next fiscal year:

A final report should be ready by fall of this year and any further plans will be confirmed after the report is completed.

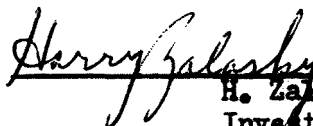
Planned reports and publications:

Zalasky, H. Incidence of D. tumefaciens in branch stubs of infected poplar. Canadian Journal Botany.

Zalasky, H. Root infections in poplar caused by D. tumefaciens. Canadian Journal Botany.

Zalasky, H. Perfect state of D. tumefaciens in poplar. Canadian Journal of Botany.

20. Signature(s):

  
 \_\_\_\_\_  
 H. Zalasky  
 Investigator

March, 1971

PROJECT REVIEW STATEMENTFiscal Years 1971-1972

- |                                                           |                  |                                                                                                                                    |              |
|-----------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1. Establishment:                                         | Prairies Region. | Date Prepared:                                                                                                                     | March, 1971. |
| 2. Title:                                                 |                  | Aerobiology of Comandra blister rust, <u>Cronartium comandrae</u> .                                                                |              |
| 3. Investigator:                                          |                  | J. M. Powell.                                                                                                                      |              |
| 4. Year of Commencement:                                  |                  | 1964.                                                                                                                              |              |
| 5. Estimated Year of Completion:                          |                  | Original 1969.<br>Revision I 1971.<br>Revision II Indefinite.                                                                      |              |
| 6. Key Words not in Title:                                |                  | <u>Pinus</u> , - Spore dispersal, germination, viability, microflora, fauna, climate, SA 1, B 19.                                  |              |
| 7. Discipline:                                            |                  | Pathology.                                                                                                                         |              |
| 8. Project Group:                                         |                  | Reduction of losses from bark diseases.                                                                                            |              |
| 9. Estab. Proj. No.:                                      |                  | Service Proj. No.: NOR 094.                                                                                                        |              |
| 10. Status at time of statement preparation:              |                  | Active.                                                                                                                            |              |
| 11. Estimated total man-months utilized to date:          |                  | Prof.: 46 Other: 71                                                                                                                |              |
| 12. Man-months utilized in two fiscal years under review: |                  | Prof.: 18 Other: 24                                                                                                                |              |
| 13. Man-month requirements in next fiscal year:           |                  | Prof.: 4 Other: 2                                                                                                                  |              |
| 14. Location of Work:                                     |                  | Calgary, Kananaskis Forest Experiment Station, in forested regions of Alberta and National Parks.                                  |              |
| 15. Background Statement:                                 |                  |                                                                                                                                    |              |
| a. Project proposed by:                                   |                  | Canadian Forestry Service.                                                                                                         |              |
| b. Objectives:                                            |                  | To investigate the epidemiology and aerobiology of the Comandra blister rust on lodgepole pine and its alternate hosts in Alberta. |              |

- Interim:
1. Determine the duration of aeciospore production and factors affecting their release, transport, dispersal and deposition;
  2. Determine the environmental factors affecting aeciospore germination and viability;
  3. Determine the effect of the associated microflora and fauna on aspects of the aerobiology;
  4. To conduct surveys to ascertain the distribution of the rust in the region, and the incidence and role of the associated rodents, insects and microflora.

c. Need for project: The rust is a disease of hard pines in North America. Although the damage of the rust is not spectacular, the infection may be heavy in trees of all ages and cause mortality by basal or stem girdling. It has recently become a plantation problem in south and southeastern United States and mature stands of lodgepole pine in western United States have been reported with 50 to 98% of the trees infected. Little is known about the distribution and role of the rust in Canada.

Important information is lacking on influence of climatic factors upon spread and intensification of aerial borne pathogens. This rust, which has an easily recognizable aeciospore stage was chosen as a suitable organism for studies on those relations, and because it is a potentially damaging organism, especially with the increase toward plantation forestry, for which little information was available.

d. Co-operating Agencies: None.

16. Accomplishments to beginning of fiscal years under review: Aeciospore production and duration was followed for four years in a number of locations, including production in two years from individual aecia and aecial pustules. Aecial production was limited by the activity of other fungi, insects and rodents. Sixty-four fungi and bacteria were identified as associated with the rust canker or spores; of these Tuberculina maxima and Cladosporium sp. are important in reducing the inoculum available. One hundred and seventeen species of mites and insects were collected in association with the rust. Of these Epuraea obliquus, Paracacoxenus guttatus and an unidentified Cecidomyiidae, play an important role, and information on their biology was obtained. Annual observations were made on the incidence of rodent, insect and microfloral organisms on 500 cankers at 23 locations, as well as observations on the growth and status of the cankers.



Seasonal and diurnal spore release data were collected during four years, and related to weather. Data were collected on the distance of spore dispersal from natural and experimental sources, and on the rate of spore fall in still air. Spore germination tests were made daily during the spore production period in three years. The temperature, humidity, light and pH requirements for spore germination were established. Different media were evaluated as spore germination substrates. The cytology of the aeciospores and aeciospore germ tubes were described. Inoculations were successful with aeciospores on Comandra, very poor on Geocalon, and negative results were achieved on pine. Information was obtained during four years on the build-up of uredial and telial infection on eight Comandra plots.

Papers were published on the development of a modified 24-hour spore collector, on a cage for collecting insects from cankers, and the first report of the rust on P. sylvestris and of the hyperparasite Tuberculina maxima on C. comandrae and other pine stem rusts in Alberta. A manuscript of a Ph.D. thesis entitled "The aerobiology of the aecial state of the comandra blister rust, Cronartium comandrae Peck, in Alberta" was completed and approved by the thesis committee. A draft of a paper was prepared on the cytology of the aeciospores and aeciospore germ tubes of C. comandrae and C. comptoniae with Y. Hiratsuka (Project No. 026).

17. Goals set for fiscal years under review:

The thesis requirements will be completed. Attempts will be made to obtain additional data in 1969 on distance of aeciospore dispersal, infection and phenology of the various states of the rust. Measurements of canker growth rates, mortality, and incidence of associated fungi, insects and rodent damage will be continued in 1969 and 1970, while insect rearing and identification will be completed for objectives 15 (c) and (d).

A series of papers and reports will be prepared for publication, and hopefully others can be prepared, at least in a draft form, prior to the major reassignment of the investigator in April 1971.

18. Accomplishments during fiscal years under review:

The thesis was completed, successfully defended and the Ph.D. degree awarded in May, 1969.

Additional data on distance of aeciospore dispersal and phenology of the various states of the rust were obtained in 1969. Measurements of canker growth rates and information on canker mortality, and the incidence of associated fungi, insects and rodent damage were obtained in 1969 and 1970. Arthropod rearings from pine stem rust cankers was continued in 1969. Samples of duff material from around rust infected trees were collected in April 1969 and September 1970 for arthropod rearing. Some 160 species were reared from the 1969 samples, which included 15 spiders, 21 mites, 19 Collembola, 20 Coleoptera,

43 Diptera (half Cecidomyiidae), and 22 Hymenoptera.

The paper on the nuclear condition and germination characteristics of the aeciospores of C. comandrae and C. comptoniae were published in 1969. Three papers were prepared for presentation at scientific meetings in 1969. The abstracts of two of these were published, and are indicated below. The third paper, entitled "Comandra blister rust in Alberta, and biological factors affecting aeciospore production", was presented at the Annual Meeting, Canadian Phytopathology Society (Alberta Region), Kananaskis Forest Exp. Sta., November 13, 1969.

Not as many journal publications from the thesis material were prepared in 1969-70 as hoped, as the investigator was involved with non-project work for over three months of the year (Organization for the Third Forest Microclimate Symposium, and preparation of the Symposium Proceedings; and preparation of "A Bibliography of Climatology for the Prairie Provinces, with Professor R.W. Longley, University of Alberta, to be published by the University of Alberta press).

A series of papers have been prepared during 1970-71 for publication. Three papers are in press (see below), three have been submitted to journals and one other is under review by Headquarters (see next section). Four other papers or reports are in various stages of local review and are also listed in the next section.

Powell, J.M. 1969. The aerobiology of the aecial state of the comandra blister rust, Cronartium comandrae Peck, in Alberta. Univ. British Columbia, Ph.D. thesis. 362 p.

Abstract of thesis published in Dissertation Abstracts B. 30 (9): 3939-3940. 1970.

Hiratsuka, Y. and J.M. Powell. 1969. Cytology and taxonomy of autoecious pine stem rusts. (Abs.) In XIth Int. Bot. Congr. Seattle, Wash. Aug. 24 - Sep. 2, 1969. Abstracts. p. 91.

Powell, J.M. and Y. Hiratsuka. 1969. Nuclear condition and germination characteristics of the aeciospores of Cronartium comandrae and C. comptoniae. Can. J. Bot. 47: 1961-1963, plus 2 plates.

Powell, J.M. 1969. Insects associated with pine stem rusts. (Abs.) In Proc. 17th Annu. Meeting, Ent. Soc. Alberta, Lethbridge, Alberta, Oct. 24-25, 1969 p. 8-9.

- Powell, J.M. 1970. Cronartium comandrae in Canada, its distribution and hosts. Can. Plant Dis. Survey, 50 (in press).
- Powell, J.M. 1971. Fungi and bacteria associated with Cronartium comandrae on lodgepole pine in Alberta. Phytoprotection, 52 (in press).
- Powell, J.M. 1971. The arthropod fauna collected from the comandra blister rust, Cronartium comandrae, on lodgepole pine in Alberta. Can. Entomol. 103 (in press).

19. Goals for next fiscal year: Owing to the reassignment of the investigator only limited time will be available to continue the preparation of papers and reports for publication. Hopefully those papers submitted to journals or for Ottawa review will be accepted by the journals. One invited paper on "Dispersal of Cronartium comandrae aeciospores" will be prepared for presentation at the Western International Forest Disease Work Conference, at Medford, Oregon, in September, and for publication in the Proceedings. Work will continue on the four papers under local review, and hopefully some progress can be made on other proposed papers, including the joint paper with Y. Hiratsuka on the "Pine stem rusts of Canada".

- Powell, J.M. Occurrence of Tuberculina maxima on pine stem rusts in western Canada. (submitted to Can. Plant Dis. Survey).
- Powell, J.M. Additional records of Mycodiplosis larvae (Diptera: Cecidomyiidae) feeding on rust fungi. (submitted to Can. Plant Dis. Survey).
- Powell, J.M. Incidence and effect of Tuberculina maxima on cankers of the pine stem rust, Cronartium comandrae. (proposed for Phytoprotection - paper under Ottawa review).
- Powell, J.M. Insects collected from Comandra umbellata ssp. pallida (Santalaceae) infected by the rust Cronartium comandrae in southern Alberta. (Submitted to Can. Field-Naturalist)
- Powell, J.M. Seasonal and diurnal periodicity of Cronartium comandrae aeciospore release from stem cankers on lodgepole pine. (proposed for Can. J. Bot. or Can. J. For. Res. - paper under local review).
- Powell, J.M. Daily germination of Cronartium comandrae aeciospores. (proposed for Can. J. Bot. - paper under local review).
- Powell, J.M. Environmental factors affecting germination and germ tube growth of Cronartium comandrae aeciospores. (proposed for Can. J. Bot. - paper being revised for local review).

Powell, J.M. The effect of temperature, humidity and light on the viability of Cronartium comandrae aeciospores. (proposed Inform. Rept. - paper being revised for local review).

Powell, J.M. Dispersal of Cronartium comandrae aeciospores (Invited paper for W.I.F.D.W.C., Medford, Ore., Sept. 1971).

Hiratsuka, Y. and J.M. Powell. Pine stem rusts of Canada. (Proposed Dept. Publ.).

20. Signatures:



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J.M. Powell,  
Investigator.

March, 1971.

PROJECT REVIEW STATEMENT

Fiscal Year: 1971-1972

1. Establishment: Prairies Region. Date Prepared: March, 1971.
2. Title: Liaison and technical advisory services re insect pests and diseases of forest, shelterbelt and ornamental trees.
3. Investigator: V. Hildahl.
4. Year of Commencement: 1966.
5. Estimated Year of Completion: Continuing.
- \*6. Key Words not in Title: Tree biology, entomology, pathology, pesticides, insect control, disease control, demonstrations, spraying, surveys, appraisals, wildlife.
7. Discipline: Liaison and Development.
8. Project Group: Liaison, Development and Forestry Services.
9. Estab. Proj. No.: MS 069 Serv. Proj. No.: NOR 068.
10. Status at time of statement preparation: Active.
11. Estimated total man-months utilized to date: Prof.: 60 Other: 26
12. Man-months utilized in fiscal year under review: Prof.: 12 Other: 4
13. Man-month requirements in next fiscal year: Prof.: 9 Other: 6
14. Location of Work: Manitoba.
15. Background Statement:
  - a. Project proposed by: Canadian Forestry Service (at the request of Provincial Forestry, Park and Agricultural agencies).
  - b. Objectives: To develop and maintain regular contact with Provincial Forestry, Park and Agricultural agencies, woods operating industries, nursery operators, and city and municipal officials and 2) provide these agencies with technical guidance and assistance in dealing with insect and disease problems of forest, park and shelterbelt trees within their jurisdiction.

c. Need for project: The primary need for the project is to develop harmonious working relationships and promote effective communication with administrative, research and operational personnel associated with the fields of forestry, recreation and urban beautification in order to 1) ensure that the user agencies derive maximum benefits from the results of research and development programs in entomology and pathology; and 2) provide feedback on the needs and views of user agencies to research managers for the initiation of meaningful research programs which will effectively contribute to resolving insect and disease problems associated with forest and planted trees.

This involves keeping them informed of current insect and disease problems; interpreting and disseminating results of scientific research that has practical application in dealing with insect and disease problems; advising user-agencies with respect to latest chemical controls; field testing of chemicals appropriate to insect and disease control; and developing, demonstrating and supervising large-scale operational control programs that are beyond the competence of the user-agency.

d. Co-operating agencies:

1. Forestry Branch, Manitoba  
Department of Mines and Natural Resources.
2. Parks Branch, Manitoba  
Department of Tourism and Recreation.
3. Plant Protection Division,  
Manitoba Department of Agriculture.
4. Urban and Rural Parks,  
City and Municipal officials.
5. Entomology and Pathology  
Departments, University of Manitoba.

16. Accomplishments to beginning of fiscal year under review:

1. Since the Liaison and Services Section (Tree Insects and Diseases) was established in 1966, contacts have been developed and maintained with federal, provincial, municipal and urban governmental agencies, and with industrial and university officials associated with forestry and tree growing problems.

2. In association with Dr. R.F. DeBoo, Chemical Control Research Institute, operational spray programs were conducted in 1967 at the request of the Manitoba Department of Mines and Natural Resources (Forestry Branch). The work was carried out in pine plantations in the Spruce Woods Provincial Forest and in natural jack pine stands in the Belair and Sandilands Provincial forests to demonstrate chemical control techniques for suppressing jack-pine budworm larval populations with aerial application equipment.

3. At the request of the Manitoba Department of Tourism and Recreation (Parks Branch), companion studies using hydraulic sprayers and mist blowers were conducted from 1967-1969 in the Whiteshell Provincial Park and at Rocky Lake in northern Manitoba. The work was carried out primarily to test the suitability of ground application equipment for treating localized jack-pine and spruce budworm outbreaks. In association with this study several insecticides were tested for efficacy, and application techniques were developed that could be readily used by park and forestry personnel.

4. Dutch elm disease detection programs have been carried out jointly with officials of the Manitoba Department of Agriculture and of Metropolitan Winnipeg. The possibility of this serious disease spreading to elm stands in Manitoba from adjacent Minnesota has caused considerable concern to various governmental agencies, and the need for early diagnosis of the pathogen is essential.

5. Detailed appraisal has been made of jack pine mistletoe infections in two areas proposed for clear cutting in the Belair Provincial Forest at the request of the Manitoba Department of Mines and Natural Resources (Forestry Branch). Boundaries of the infected area were delineated, and a report entitled "Management Control of the Jack-Pine Mistletoe in the Belair Provincial Forest" was prepared and submitted to the above agency.

6. Several appropriate special reports have been prepared and submitted at the request of the provincial Parks Branch and Forestry Branch. Liaison and Services publications produced were as follows:

Hildahl, V., R. Pratt and A. Campbell. 1968. Bibliography of Forest Research. Canada Dept. of Fisheries and Forestry, Liaison & Services Note MS-L-2. 65 p.

DeBoo, R.F. and V. Hildahl. 1968. Jack-Pine Budworm in Central Canada. Canada Dept. of Fisheries and Forestry, Liaison and Services Note MS-L-4. 9 p.

Peterson, L.O.T. and R.F. DeBoo. 1969. Pine Needle Scale in the Prairie Provinces. Canada Dept. of Fisheries and Forestry, Liaison & Services Note MS-L-5. 9 p.

Peterson, L.O.T. and V. Hildahl. 1969. The Spruce Spider Mite in the Prairie Provinces. Canada Dept. of Fisheries and Forestry, Liaison & Services Note MS-L-7. 9 p.

Hildahl, V. and L.O.T. Peterson. 1970. Spruce and Balsam Fir Sawflies in the Prairie Provinces. Canada Dept. of Fisheries and Forestry, Liaison & Services Note MS-L-10. 10 p.

DeBoo, R.F. and V. Hildahl. 1968. Aerial Spraying for Control of the Jack-Pine Budworm in Manitoba. *Manitoba Entomologist*. 1:21-26.

17. Goals set for fiscal year under review:

1. Continued liaison with resource managers throughout Manitoba; contacting appropriate governmental agencies and officials of wood-using industries.
2. Continue conducting insecticide testing and spraying in association with Dr. R.F. DeBoo, Chemical Control Research Institute; with emphasis on experimental spraying to control the poplar bud-gall mite on hybrid poplars. This mite is a serious pest of planted poplars in the prairie regions.
3. Continue detection programs for the Dutch elm disease in southern Manitoba with emphasis on the Red River Valley section, and provide laboratory services for diagnosis of unhealthy and suspect elm trees.
4. Preparation of appropriate special reports, scientific papers and Liaison and Service publications for distribution to resource managers and other user-agencies.

18. Accomplishments during fiscal year under review:

1. Contacts with officials of the provincial Forestry Branches, Agriculture, National and Provincial parks, and city and rural parks were continued, and information provided as required on the status and control of various insect pests and tree diseases.
2. Detailed appraisal re jack pine mistletoe was continued in the Belair Provincial Forest and expanded to the Grand Beach Provincial Park. Appropriate special reports outlining recommendations were submitted to departmental officials.
3. Dutch elm disease investigations (including detection and diagnostic services) were continued jointly with Manitoba Department of Agriculture and Metropolitan Winnipeg officials. Some 342 suspect white elms were sampled and the material cultured for diagnosis of the disease.

4. Publications completed during the fiscal year under review were:

DeBoo, R.F. and V. Hildahl. 1970. Control of the Jack-Pine and Spruce Budworms with Ground Application Equipment in Manitoba. (In press).

Hildahl, V. 1971. Dutch Elm Disease, a Threat to Prairie Elms. *The Prairie Garden* (published by Winnipeg Horticultural Society). (In press).



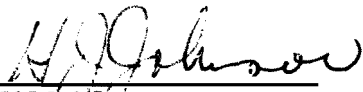
## 19. Goals for next fiscal year:

1. Liaison will be continued in Manitoba; contacting appropriate officials of Government, Municipal and Industrial agencies. This will include providing technical and advisory services with respect to insect and disease problems of trees as required.

2. Experimental spraying to control insects and diseases of trees will be continued in association with R.F. DeBoo, Chemical Control Research Institute. Emphasis in 1971 will be placed on developing chemical control recommendations for the poplar bud-gall mite.

3. Insect and disease appraisals will be conducted as requested by the various governmental agencies, and appropriate special reports and Liaison and Services publications will be prepared for distribution to resource managers and other user-agencies.

## 20. Signatures:

for   
V. Hildahl,  
Investigator.

March, 1971.