S T U D Y S T A T E M E N T S

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NORTHERN FOREST RESEARCH CENTRE

CANADIAN FORESTRY SERVICE

JULY, 1974

NOR 026

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 29, 1974

1. Project: Detection and Appraisal of tree pests and vegetative disturbances.

2. Title: Forest tree rusts of western North America.

3. New: Cont.: X 4. No.: NOR 026

5. Study Leader: Y. Hiratsuka

6. Key Words: *Cronartium*, *Pucciniastrum*, *Peridermium*, *Melampsora*, *Chrysomyxa*, cytology, morphology, taxonomy, Uredinales, inoculation experiment, pathogenicity.

7. Location of Work: Edmonton (laboratory, greenhouse and mycological herbarium), Kananaskis Forest Experiment Station, Western North America with particular emphasis on Northern Region (field).

8. Problem:

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 southeastern 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.

9. Study Objectives:

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General:

To acquire a comprehensive knowledge and to improve diagnostic capability on the forest tree rusts of western North America with particular emphasis on the Northern 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 poplar-conifer rusts of the region, and related species in the world.

10. Resources:

a. Starting date: 1968 Projects A-232 (1961) and A-254 (1965) were combined and redesigned in 1968.
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years

Prof.	0.5	(Y. Hiratsuka)
Supp.	0.5	(P.J. Maruyama)
Casual	Nil	
Total	1.0	0 & M funds req'd:

11. Progress to Date:

1. Comparative studies of the nuclear phenomena of the aeciospores and germinating aeciospores of *P. harknessii* and *P. stalactiforme* have been completed and the results have been published. Further nuclear studies have been carried out with the aeciospores of *P. harknessii* material from other regions. Similar studies with *C. comptoniae* and *C. comandrae* were completed and results have been published.

2. Studies on temperature and pH requirements for an orange and white stored 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 outlined.

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.

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

11. 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.

12. Surveys of the occurrence of *Tuberculina maxima* on pine stem rusts have been undertaken. Two papers on the occurrence have been published.

13. Field and herbarium surveys of the occurrence of the pine stem rusts in Canada have been carried out and distribution maps were prepared.

14. The first draft of the proposed publication "Pine stem rusts of Canada" has been completed and under review.

15. Modified and improved sets of terminology of spore states in Uredinales (rust fungi) were proposed at the First International Mycological Congress (1970) and a comprehensive paper on the subject has been published.

16. To clarify the nomenclatural confusion created by the discovery of a new life cycle of pine stem rusts, conservation of the generic name *Peridermium* has been proposed.

12. Goals for 1973-74:

1. Continue inoculation experiments with western gall rust on native and exotic pine species. Study mode of penetration of the pathogen on pine tissues.

2. Complete and publish morphological study on the genus *Chrysomyxa* in North America.

3. Complete a manuscript proposing the conservation of a generic name *Peridermium*.

4. Critical comparative study of pine stem rusts and other forest tree rusts will be carried out in conjunction with the study trip to Asia from March to August, 1973.

13. Accomplishments in 1973-74:

1. Several inoculations were made with western gall rust on native and exotic pine species. Morphological and histological study of gall development has been started.

2. Scanning electron micrographs of all North American *Chrysomyxa* spp. were prepared and morphological comparisons were made.

3. Manuscript proposing the conservation of a generic name *Peridermium* has been completed and submitted to Taxon.

4. Study trip to India, Japan and Korea was successfully carried out and several significant results were obtained.

5. Serious damage caused by two pine stem rusts to a lodgepole pine plantation in central Alberta was studied and a report has been published.

14. Goals in 1974-75:

1. Gall development of western gall rust will be studied by scanning electron microscope, cell maceration technique and other histological and cytological methods.

2. Start a study on epidemiology of western gall rust on lodgepole pine in managed forest.

3. Revise the ms of a departmental publication "Pine stem rusts of Canada" for final review.

4. Complete a morphological study of Chrysomyxa of North America.

5. Complete the ms on ontogeny of spore markings of pine stem rusts for a journal publication.

6. Compile the "Check list of Uredinales in Alberta" for information report.

7. Study the results and examine the specimens obtained from the study trip to Asia in 1973.

15. Publications:

Up to 1973-74

Powell, J. M. and W. Morf. 1965. The occurrence of *Tuberculina maxima* Rost. on *Cronartium* rust infected trees in Alberta. Can. Dept. For., For. Ent. and Path. Br., Bi-Mon. Prog. Rept. 21(1):3.

Powell, J. M. 1966. A white spored *Peridermium stalactiforme* in Alberta. Plant Disease Reporter, 50:114.

Powell, J. M. and W. Morf. 1966. Temperature and pH requirements for aeciospore germination of *Peridermium stalactiforme* and *P. harknessii* of the *Cronartium coleosporioides* complex. Can. J. Bot. 44:1597-1606. + 1 plate.

Hiratsuka, Y., W. Morf and J. M. Powell. 1966. Cytology of the aeciospores and aeciospore germ tubes of *Peridermium harknessii* and *P. stalactiforme* of the *Cronartium coleosporioides* complex. Can. J. Bot. 44, 1639-1643. III Plats.

Hiratsuka, Y. and E. J. Gautreau. 1966. Occurrence of *Cronartium comptoniae* in Alberta and the Northwest Territories. Pl. Dis. Reptr. 50, 419.

Hiratsuka, Y., L. E. McArthur and F. J. Emond. 1967. Clarification of the identity of two needle rusts of alpine fir, *Pucciniastrum geoppertianum* and *P. epilobii* in Alberta. Can. J. Bot. 45, 1913-1915.

Hiratsuka, Y. and P. J. Maruyama. 1968. Nuclear condition of the germ tubes of *Peridermium ephedrae*. Mycologia 60, 437-438.

Hiratsuka, Y. and P. J. Maruyama. 1968. Identification of *Peridermium harknessii* in eastern Canada on the basis of nuclear condition of aeciospore germ tubes. Pl. Dis. Reptr. 52, 650-651.

Hiratsuka, Y. 1968. Morphology and cytology of aeciospores and aeciospore germ tubes of host-alternating and pine-to-pine races of *Cronartium flaccidum* in northern Europe. Can. J. Bot. 46, 1119-1122. IV plates.

Hiratsuka, Y. and J. M. Powell. 1969. Cytology and taxonomy of autoecious pine stem rusts. (Ab.). XI International Botanical Congress. Seattle, Washington, Abstracts:91.

Hiratsuka, Y. 1969. *Endocronartium*, a new genus for autoecious pine stem rusts. Can. J. Bot. 47, 1493-1495.

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. 2 plates.

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 electron microscope. Can. J. Bot. 48, 1962.

Krebill, R. G. and Y. Hiratsuka. 1971. Possible life cycle and nuclear condition of *Peridermium ephedrae*. Southwestern Naturalist 16:431-459.

Powell, J. M. 1971. Occurrence of *Tuberculina maxima* on pine stem rusts in western Canada. Can. Plant Dis. Surv. 51(2):83-85.

Powell, J. M. 1971. Additional records of *Mycodiplosis* larvae (Diptera:Cecidomyicdae) feeding on rust fungi. Can. Plant Dis. Sum. 51(2):86-87.

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

Hiratsuka, Y. 1973. Sorus development, spore morphology, and nuclear condition of *Gymnosporangium gaeumanii* ssp. *albertense*. Mycologia 65:137-144.

1973-74

Hiratsuka, Y. 1973. The nuclear cycle and the terminology of spore states in Uredinales. Mycologia 65:432-443.

Hiratsuka, Y. 1973. Nuclear cycle, taxonomy, and nomenclature of autoecious pine stem rusts in North America and Europe. Rep. Tottori Mycol. Inst. 10:243-248. (In Japanese with English summary.)

Powell, J. M. and Y. Hiratsuka. 1973. Serious damage caused by stalactiform blister rust and western gall rust to a lodgepole pine plantation in central Alberta. Can. Dis. Surv. 53:67-71.

Hiratsuka, Y. Proposal to conserve the generic name *Peridermium* (Link) Schmidt and Kunze with a conserved type species *Aecidium eleatinum* Alb. and Schw. (Fungi Imperfecti Uredinearum). Taxon (In press)

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 29, 1974

1. Project: Detection and appraisal of tree pests and vegetative disturbances.

2. Title: Forest insect and disease survey.

3. New: Cont.: X 4. No.: NOR 033

5. Study Leader: W.G.H. Ives, Y. Hiratsuka, H.R. Wong, R.A. Blauel

6. Key Words: Detection, appraisal, distribution, parasites, hosts, damage, predators, biological control, hazard, susceptibility, stability, management, parks, recreation, symptoms, damage, effluents, easement atmosphere.

7. Location of Work: Throughout region.

8. Problem:

Forest insects and diseases annually destroy or degrade large quantities of otherwise usable wood fibre. They cause important damage to nursery plantations, shelterbelts and park plantings which have high aesthetic or shelter values. The relations between insects, diseases and their hosts are complex and often obscure. Many of the problems confronting resource managers have their origin in insect or disease activities, but in other instances unsuspected factors may be responsible for the damage, and the insects or diseases are of secondary importance. Correct diagnoses therefore require a highly trained technical and professional staff.

The data collected by the Survey provide essential information on life cycles, ecology, natural control agents, distribution and general abundance, which is of value to research entomologists, pathologists and other biologists. Many of the species reported by the Survey have a wide distribution, and the regional data are part of a larger body of data collected by this and other regions. There is a feeling in some quarters that this body of data has limited value, and that enough information on insect and disease outbreaks has already been collected. For some organisms, there is some truth in this argument, but for many species the statement is not true. The spruce budworm, for example, reaches outbreak proportions perhaps every 35 to 75 years, and the 35 year period covered by the Survey usually contains data on only one outbreak. Recent work has shown

that the general information collected by the Survey can be used in a meaningful manner to help explain fluctuations in insect abundance. Requests for surveys and advisory services in environmental, pest and pollution problem areas are being directed with increasing frequency to the Canadian Forestry Service. The Forest Insect and Disease Survey (FIDS) can handle many of these requests. Current problems are as follows:

a. Forest insects and diseases influence the stability of certain forest cover types in the National Parks. Planners laying out campgrounds, nature trails, wilderness sectors etc., require information on that subject. Prior knowledge will permit, in some circumstances, more effective planning which will ensure recreational and aesthetic objectives can be maintained on a long term basis.

b. Within the Region covered by the Northern Forest Research Centre large industrial complexes are involved with extraction and refinement of basic resources. Most of these are located within forested areas. Provincial resource managers and industry are concerned that significant damage may occur to forests from process effluents emitted into the atmosphere. The Forest Insect and Disease Survey historically has provided an insect and disease surveillance throughout the region where the complexes are located. The Provincial and industrial managers have requested pollution damage surveillance be provided in several specific areas. The Forest Insect and Disease Survey has been charged with providing that service.

c. Severe winter damage to lodgepole pine occurs periodically in stands along the foothills in Alberta. During the winter of 1971-72, particularly severe damage occurred in the Coal Branch area. Although the extent and severity of damage was unknown it appeared to be substantial. The Coal Branch area is relatively accessible, so that salvage cutting of some stands would be feasible if the damage was severe enough to warrant it.

d. Dwarf mistletoe is a parasite of large areas of jack pine in the three Prairie Provinces. However, the distribution is spotty, and since the parasite spreads very slowly, there are areas more severely affected than others. The Alberta Forest Service (AFS) requested assistance in assessing the incidence of dwarf mistletoe on jack pine in their Management Unit A7, northeast of Fort McMurray, as they were interested in the possibility of ultimately improving the quality of stands by cleaning out residuals after fire.

9. Study Objectives:

a. 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.

b. To provide management agencies with advisory services to meet current problems. Specifically, these are:

1. To provide National and Historic Parks Branch with an assessment of short and long term effects insects and diseases will have on stability of forest cover in those parks.

2. Detect, delineate and assess effects of air pollutants upon vegetation.

3. To assess the extent and severity damage caused by red belt.

To determine if gross symptoms of damage to individual trees can be related to the ultimate damage to the stands.

4. To develop and test an aerial survey technique for mapping the incidence of dwarf mistletoe on jack pine.

10. Resources:

a. Starting date: 1941 at Winnipeg and Indian Head
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years

Prof.	0.5	(W.G.H. Ives)
	0.5	(Y. Hiratsuka)
	0.5	(H. R. Wong)
	0.8	(R. A. Blauel)
Supp.	1.0	(J. K. Robins)
	1.0	(J. Petty)
	1.0	(V. B. Patterson)
	1.0	(F. J. Emond)
	1.0	(J. J. Lawrence)
	1.0	(J.C.E. Melvin)
	0.3	(P. J. Maruyama)
	0.75	(R. M. Caltrell)
	1.0	(J. P. Susut)
	0.8	(G. J. Smith)
	1.0	(G. N. Still)
	0.7	(R. C. Tidsbury)
	1.0	(E. J. Gautreau)
	1.0	(N. W. Wilkinson)
Casual	0.5	
Total	15.8	O & M funds req'd:

11. Progress to Date:

Infestations of all the major forest insects 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. Much of this information has been stored on magnetic tape or punch cards

for easy analysis and retrieval. Life cycles and other biological data have been obtained for most of the major insects and diseases within the region. Numerous impact and appraisal surveys have been carried out in response to special needs.

Pest conditions in the Prairies Region during 1972 were highlighted by the continued increase in forest tent caterpillar populations in Manitoba and Saskatchewan and by the occurrence of a large area of spruce infected with needle rusts in Alberta. Forest tent caterpillar defoliation occurred at scattered locations across central Manitoba and in parts of northern Saskatchewan and a major outbreak appears to be developing. Spruce budworm populations remained at much the same levels as in 1971, with most of the defoliation confined to the Sprucewoods and Interlake areas of Manitoba. Large aspen tortrix populations were on the increase across the Region and, in Manitoba, were often mixed with forest tent caterpillar. Defoliation by the fall cankerworm increased in Manitoba and Saskatchewan, and was especially noticable in metropolitan Winnipeg. Jack pine budworm infestations also increased in severity in the Sandilands Provincial Forest in Manitoba. The birch skeletonizer caused moderate to severe damage in parts of Saskatchewan and Manitoba and defoliation by the yellow-headed spruce sawfly was widespread and severe in the agricultural areas, especially in Alberta and Saskatchewan.

The spruce budworm and spruce beetle infestations in Alberta have both subsided. No special budworm survey in Alberta was required, and the survey for the spruce beetle indicated that the 1972 survey will be the last required for that insect, although checks will have to be made by the ranger in the area in case there is a resurgence in populations. Stand deterioration in the reserve block was evaluated, and an annual examination will be required for a number of years, since many dead trees are still standing. The spruce budworm infestation continued in the Sprucewoods area of Manitoba, and was surveyed by staff from the Winnipeg sub-office.

Work continued on the maintenance and improvement of the regional insect and disease reference collections.

Editing of historical data on insects neared completion.

Printouts of insects and diseases collected in each of the western national parks were obtained. Annotated check lists of forest fungi collected in Yoho and Kootenay National Parks were published. Similar lists for insects collected in Waterton Lakes National Park and in the Kananaskis Forest Experiment Station area neared completion. Lists of insects collected in each of the remaining western national parks were being compiled.

The progress in the various advisory services was as follows:

1. Ground surveys of insect and disease conditions in Waterton Lakes National Park were conducted, data were extracted from the

historic file and a hazard rating was devised. The report "Insect and Disease Hazard in Relation to Stand Stability", by J. Petty and W.G.H. Ives was completed and submitted to the National and Historic Parks Branch where it was favorably received. No field work was done in 1971-72. In 1972-73, information on forest insects and diseases in Prince Albert National Park were summarized, field surveys to supplement this information were completed, and work began on preparing color-coded hazard maps for the entire park.

2. A limited but fairly intensive aerial and ground check of vegetation in the vicinity of Thompson, Manitoba, revealed two areas, in total of approximately 50 square miles, where damage was occurring due to effluents released from the International Nickel Company plant in Thompson. Damage varied from incipient to severe. The surveys were carried out in cooperation and with assistance from the Manitoba Government and the International Nickel Company. Two reports were submitted to the agencies concerned.

An aerial survey with ground checks was carried out over a recently developed natural gas field in western Alberta and within long established oil and natural gas fields in other parts of that Province. No significant damage to vegetation was detected with the exception of a few minor damage areas resulting from well blow-outs. A report was submitted to appropriate Alberta Government agencies.

A ground check was made of vegetation damage resulting from a blow-out from a high pressure condensate line in western Alberta. Resultant gas-liquid mixture caused some discoloration of adjacent foliage, which extended a distance of two miles from the pollutant source. A report was submitted to the appropriate Alberta Government agencies.

In 1972-73, the following was accomplished:

The Thompson Smoke Easement Survey

An aerial reconnaissance, a ground appraisal and a ground truthing were carried out in the suspect fume damaged forest areas around Thompson, Manitoba. The fume damaged areas were delineated and current levels of damage were documented at 14 different sites. Ground truthing was coordinated with remote sensing procedures conducted by CCRS.

Smelter Fume Damage near Flin Flon

A preliminary air and ground appraisal was performed to determine the effects of ore smelting air pollutants on the forest in the Flin Flon-Creighton areas of Manitoba and Saskatchewan. Apparently damaged areas were located and some preliminary documentation of the damage was carried out. A brief ground

truthing complemented low level multispectral imagery obtained from CCRS.

The Effects of the Cement Production Industry on the Forest Community in the Exshaw Area

A survey was conducted to assess the condition of the forest community subjected to the air pollutants from the cement production industry near Exshaw, Alberta. Sampling of vegetation, stem analysis and other documentation procedures were performed.

The Effects of Potash Industry Pollutants on Trees and Shelterbelts near Guernsey, Saskatchewan

A preliminary survey was conducted in the Guernsey, Saskatchewan area to determine and document the effects of the potash production industry on trees and shelterbelts. Some of the vegetation examined was found to be damaged, symptoms and foliar analysis indicating chemical burning.

The Impact of Air Pollutants from the Alberta Tar Sands Oil Extraction Industry on the Surrounding Forest

A survey was conducted to determine the impact of the pollutants on the forest community near several sulphur dioxide monitoring stations located in the area. It was also determined that the monitoring stations were located out of the main air pollutant impingement area.

Forest Damage Resulting from a Light Hydrocarbon Spray Released From a Gas Pipeline

To delineate the area of damage, and to determine plausible restoration procedures, an appraisal was performed to determine the extent and progression of damage to the forest subjected to the spray.

The Effects of Air Pollutants from the Gas Processing Industry on the Forest Community in the Rocky Mountain Foothills

The survey is contributing to the detection aspects of an in-depth study to determine the effects of sulphur pollutants on the forest community. In 1972, a joint brief by the Canadian Forestry Service and the Environmental Protection Service was presented at a hearing conducted by the Alberta Government, concerning an application by Gulf Oil of Canada Ltd., for exemption from minimum sulphur recovery guidelines.

Pollutant Damage to the Forest Community in the Swan Hills Area

A preliminary detection and appraisal survey revealed that the forest community is being affected by gas flaring, sulphur gas releases, hydrocarbon coating, condensate spraying, saline

pipelines ruptures and oil spills.

The Effects of Air Pollutants from the Prince Albert Pulpmill on the Surrounding Forest Community

A small area of air pollutant damage was noted near the Prince Albert pulpmill. A preliminary appraisal survey was conducted and a report issued.

Other brief assessments of pollutant releases were conducted during the field season at the request of provincial forest management and environmental agencies. These assessments included determination and documentation of pollutant effects. The problems included a volatile hydrocarbon release in the Black Diamond area, a sulphur gas release in the Crossfield area, battery site air pollutants in the Savanna Creek area, spray drifting in the Penhold area, suspect pollutant damaged forest near the Blue Ridge gas processing plant and summertime discoloration of street trees in Prince Albert.

3. A successful air photo survey technique was devised and has been used by the Alberta Forest Service (AFS) to map red belt areas. Two sample areas were examined three times, and some of the areas mapped by AFS were ground checked during the winter. It appeared that it will be possible to relate gross symptoms of original damage to the eventual fate of some trees.

4. a. The equipment for aerial surveying of dwarf mistletoe was designed and tested.

   b. Ground checks indicated the aerial surveys to be reliable in the detection of mistletoe infections.

   c. Management Unit A7 was surveyed and the data obtained supplied to the AFS, who have used it in preparing type maps of the area, in which mistletoe infection is indicated by one of three categories.

12. Goals for 1973-74:

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 accessible forested areas presently under utilization, and to high use recreational areas.

2. Maintenance and improvements of regional insect and disease reference collections will be carried out.

3. Annotated check lists of forest diseases for Prince Albert and Riding Mountain National Parks will be prepared. Any check lists for forest insects that were not completed in 1972-73 will be completed.

4. Complete a report of insect and disease hazard for Prince Albert National Park and submit it to National and Historic Parks Branch.

5. In cooperation with management agencies within the region to provide a survey and assessment of air pollution effects on vegetation in forested regions. The areas to be surveyed will be determined after requests for inspection have been received and cannot be specified at this time.

6. a. Continue ground truthing of aerial photos of red belt areas.

   b. Continue to make observations on the condition of surviving trees.

   c. Conduct ground and/or aerial surveys of other areas where red belt damage has occurred.

7. a. Reports on aerial survey of dwarf mistletoe will be completed, if not already done in 1972-73.

   b. If management agencies in Manitoba and/or Saskatchewan are interested, and willing to provide an aircraft, pilot and navigator, the technique will be demonstrated in one or both provinces.

13. Accomplishments in 1973-74:

1. There were no significant changes in the status of major insect or disease pests in the Region in 1973. As in 1972, spruce budworm defoliation was largely confined to the Sprucewoods and Interlake areas of Manitoba, although some damage was noted in Alberta. Forest tent caterpillar infestations in Manitoba and Saskatchewan increased slightly, but not as much as had been expected, while those in Alberta remained fairly static. Most infestations of the large aspen tortrix declined, although there were still some patches of moderate to severe defoliation in Manitoba and Saskatchewan. The yellow-headed spruce sawfly continued to cause severe defoliation in the agricultural areas of the Region, while the fall cankerworm and jack pine budworm caused localized damage. Populations of the larch sawfly were generally low throughout the Region, except for an area south of The Pas in Manitoba.

   Two species of needle rusts on spruce and a combination of two leaf spot organisms on balsam poplar again caused considerable discoloration of the foliage of these trees in Alberta. Other foliar diseases were common in various parts of the Region. Fire blight and climatic damage were reported from a number of localities.

2. Work continued on the maintenance and improvement of regional insect and disease reference collections.

3. Annotated check lists of insects of Riding Mountain, Prince Albert, Elk Island, Jasper, Banff, Kootenay, Yoho and Waterton Lakes National Parks and Kananaskis Forest Experiment Station require only introductions to be ready for printing. This will be a No. 1 priority in January and February and will be out before March 31. The annotated check lists of diseases for Prince Albert and Riding Mountain National Parks have been postponed until 1974-75 because of the large quantity of newly collected material.

4. The report on insect and disease hazard for Prince Albert National Park was completed and submitted to National and Historic Parks Branch.

5. Athabasca Tar Sands Oil Industry Emissions and Effects on the Surrounding Forest

Survey and impact assessments were conducted at the request of the Government of Alberta in cooperation with the Alberta Department of Environment, Alberta Forest Service and Great Canadian Oil Sands Co. Ltd.

A survey was conducted to detect forest injuries within suspect impingement areas. Aerial surveillance techniques, aerial photo documentation methods, ground survey and ground truthing procedures were utilized. The areas surveyed displayed some foliar discolorations. However, in the areas ground truthed, discolorations were attributable to water inundations, early fall senescense, leaf diseases and leaf insects rather than sulphur gas releases. In addition, forest vegetative receptor response plots were established at three locations near continuous ambient air monitors in order to provide baseline data on the condition of the forest community for future comparative examinations. Ground cover vegetation (lichens, bryophytes, and higher plants), epiphytic corticular lichens, and tree species were documented giving the vegetative data base wide gaseous pollutant sensitivity.

Potash Production Emissions and Shelterbelt Species in Central Saskatchewan

Assessments were made at the request of the Government of the Province of Saskatchewan in cooperation with the Saskatchewan Department of Environment, Air Pollutant Control Branch.

Examinations of shelterbelts were conducted around four potash processing operations (Alwinsal, Potash Co. of America, Allan Potash Co. and Central Canada Potash of Canada). Documentation during examination included data, photographs and vegetative samples. It was found that foliar discolorations and necrosis, leader die backs, broomings and clumping occurred in many of the shelterbelts growing near the potash operations. These symptoms and injuries to shelterbelts varied, dependent on, the specific

potash operation (reflecting the pollutant emission levels released by each operation) the proximity to the potash operation (reflecting the dispersal pattern of the pollutant), and the tree species (reflecting the tolerance of the tree species to the pollutant). Results from laboratory analysis of the vegetation samples show a correlation between the presence of high concentrations of potash production pollutants in tissues and injury and symptom expression. Also, a field trial design regarding possible future assessment was submitted to the Saskatchewan Air Pollutant Control Branch.

Oil and Gas Industry Pollutant Releases in the Greater Swan Hills and other Forest Areas

At the request of the Government of the Province of Alberta and in cooperation with the Alberta Forest Service and the Alberta Department of Environment, aerial and ground survey assessments were made of:

a. Salt water spill and disposal problems:

Problem definition was done at six sites. Data gathered concerned detection, symptom identification, tree species sensitivity, current forest impact, impact event sequence, and cleanup effectiveness. Two areas were selected for more intensive examination of the movement and impact of chlorides. The areas were bench marked (site data were gathered), soil and foliar samples were collected for analysis and photo documentation was completed.

b. Condensate releases:

Assessments were conducted at two sites. Forest vegetative responses, response sequence, symptom production, and tree species sensitivity were examined. A field trial procedure for reclamation of the Strachan area condensate release was submitted.

c. Oil spills:

Assessments were made at two sites; one a fresh spill (1973) and the other a seven year old spill. Multispectral imagery was obtained and data were collected concerning detection of the spills, the impact of the oil on forest vegetation and the effectiveness of reclamation procedures.

d. Sulphur pollutant releases:

Preliminary assessments of trees and forest vegetation were conducted for various sulphur pollutant incidents: sulphur fires, oil and gas well blow-outs, battery sites, valve and/or transmission line leakages, oil and gas well servicing procedures, sulphur stockpile pouring, and sulphur stockpiles.

The assessments included sample collecting and photographic documentation of forest tree and vegetation symptom expression, species sensitivity, injury and damage.

Aerial color and infrared photography and UV scanning of a portion of the Swan Hills problem areas was performed by CCRS and integration of this imagery with ground truth data is underway.

Forest Survey of the Thompson Smoke Easement and Smelter Fume Impacts Around Flin Flon

Forest survey work in these areas was conducted in response to requests from the Government of the Province of Manitoba and done in cooperation with the Manitoba Department of Mines, Resources and Environmental Management.

Efforts were concentrated on the evaluation and interpretation of the 1972 and 1973 multispectral imagery obtained from CCRS and the processing of vegetative samples and the analysis of data obtained in the field during 1971 and 1972. The integration of this information clearly demonstrates that significant impacts from air pollutants have occurred in the two areas, indicates the complexity of forest responses to smelter fumes and shows the need for additional efforts to accurately determine forest response sequence and impact progression.

The Response of Shelterbelts in Southern Saskatchewan to Sulphur Gas Pollutants

Examinations were made at the request of the Government of the Province of Saskatchewan and done in cooperation with the Saskatchewan Department of Environment, Air Pollutant Control Branch.

Examinations of several farm shelterbelts were conducted near oil well battery sites in the Kisby area of southern Saskatchewan. Documentation included data, photographs and foliar samples. Shelterbelt species around a farmstead near one of the battery sites displayed acute foliar symptoms typical of multiple, high concentration sulphur gas fumigations.

General Detection of Forest Pollutant Incidents

Several reports were made of suspect forest pollutant incidents by the ranger staff at various locations in the prairies region. This information was made available to the appropriate resource management agencies. A few preliminary impact assessments were conducted where expedient.

6. a. Ground truthing of air photos has been completed.

b. Observations of surviving trees was carried out on four occasions and two sample plots established. Activities of root diseases and bark beetles was recorded.

c. One ground survey of five days duration was made, many photographs were taken and observations noted. No aerial survey was made.

7. a. Reports to the Alberta Forest Service have been completed with the exception of the preparation of one map that still awaits a new base map from AFS. An Information Report on the equipment used and its application to dwarf mistletoe surveys is about half finished. If not completed in 1973-74, it should be out early in 1974-75.

b. No action due to lack of interest.

Accomplishments not included in 1973-74 goals:

An appraisal survey of insect and disease damage to reproduction pine in scarified cutting blocks on the North Western Pulp and Power lease near Hinton was carried out in the fall of 1973. In all, 281 plots were examined in 46' blocks on 3 working circles. The results are summarized in a report that has been prepared.

A study on insects associated with trees killed by a release of hydrocarbon condensate near Strachan, Alberta, has been completed and a report written.

Additional photographs have been made of insects in our area causing galls and abnormal plant growths, and a number of insects associated with poplar catkins have been reared and identified.

14. Goals for 1974-75:

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 accessible forested areas presently under utilization, and to high use recreational areas. Increased emphasis will be placed on extension work, especially in Alberta and Saskatchewan.

2. Maintenance and improvements of regional insect and disease reference collections will be carried out.

3. Prepare annotated check lists of insects collected in Prince Albert and Riding Mountain National Parks.

4. In cooperation with management agencies within the region to provide a survey and assessment of air pollution effects on vegetation in forested regions. The areas to be surveyed will be determined after requests for inspection have been received and cannot be specified at this time.

5. Red belt studies will consist primarily of a follow-up of weakened trees in the Cadomin-Luscar area to determine the effects of bark beetles and possible Armillaria on the surviving trees.

6. A report on the equipment used in aerial survey of dwarf mistletoe will be completed, if not already published.

7. Prepare a report on insects of poplar catkins.

15. Publications:

Up to 1973-74

16. Signatures:

Investigator

Program Manager

Investigator

Director G. T. Silver

Investigator

Investigator

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

January 29, 1974

1. Project: Detection and appraisal of tree pests and vegetative disturbances.

2. Title: Sawfly systematics

3. New: Cont.: X 4. No.: NOR 058

5. Study Leader: H.R. Wong

6. Key Words: Tenthredinoidea, Nearctic Region, Distribution, Hosts, Keys, Life History, Morphology, New Genera, New Species, Biogeography, Revision, Symphyta, Evolution, Phylogeny.

7. Location of Work: Edmonton, Alberta

8. Problem:

To study the systematics of the sawflies of Canada. Until sawflies are identified, they cannot be discussed or treated in a scientific way. Accurate identification of pest species can determine their area of spread and assist in confining their damage to a restricted area. Systematic studies can provide the means of making predictions and generalizations about probable habits, distribution, future importance of newly discovered species, and clues on possible methods of control. It is the means by which an orderly system is provided for storing information about sawflies and is an important retrieval device.

Success in this study is excellent provided time, funds and technician assistance are available. Since I am the only one in Canada, at the present time, actively engaged in the systematic study of sawflies, any results obtained would add to the knowledge of this group of insects in Canada, and their role in our environment. Such knowledge would also aid certain biological and ecological studies in North America.

The material is made available by a number of agencies requesting identification services, in particular the Forest Insect and Disease Surveys across Canada. Species identification is generally based on the microscopic examination of the extracted genitalia, which are

mounted on slides. After comparison with available types, any new species are described and illustrated together with other pertinent information on host, life history, distribution, immature stages, phylogeny etc. Keys are constructed to assist in future identification.

9. Study Objectives:

a. 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.

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

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

d. To study the external and internal morphology of the more economic sawfly species.

10. Resources:

a. Starting date: 1950
b. Estimated year of completion: a continuing project Revised
c. Estimated total Prof. man-years required: indefinite
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.5
Supp. 0.0
Casual .30
Total 0.8 O & M funds req'd:

11. Progress to Date:

The value of cocoons in determing 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), *Melastola* (Canada and U.S.A.); and *Susana* (Canada).

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

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 new genera *Sharliphora* and *Melastola* were established.

It has been determined that the use of Mahalanobis D^2 statistic and discriminant function analysis failed to separate populations of the larch sawfly, which were resistant or susceptible to the parasite *Mesoleius tenthredinis*.

The European spruce sawfly has been discovered for the first time in southeastern Manitoba along with the parasite, *Palexorista bohemica*, which was released against it in eastern Canada.

A brochure was prepared on the life history, damage and control of the three birch leaf-mining sawflies in the Prairies.

The *Pristiphora* section of the new Hymenoptera of America north of Mexico synoptic catalog was revised for Dr. D.R. Smith, Washington D.C.

12. Goals for 1973-74:

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

2. Conclude the examination of two strains of larch sawfly for possible morphological differences in genitalia.

3. Commence work on *Pristiphora* monograph.

13. Accomplishments in 1973-74:

1. Morphological differences have been observed in the two strains of the larch sawfly. Morphological studies of over two thousand specimens of this species from Europe, Asia and North America indicate the presence of five strains. Four strains occur in North America, two of which were introduced from Eurasia when parasitized cocoons were distributed for the release of *Mesoleius tenthredinis* Morley by 1913.

2. Identified sawflies for the Canadian National Collection, the Edmonton laboratory, Dr. William Ciesla, Missoula ,Montana, and personnel of the University of Alberta, Edmonton, Alberta. This entails about .15 man years of work.

3. Made genitalic slides and illustrations of some *Pristiphora* species, for the study of strains of the larch sawfly and the revision of the genus.

14. Goals for 1974-75:

1. Identify sawflies in the Canadian National Collection and for various entomologists in Canada and the United States.

2. Prepare for publication the study on "The identification, distribution and origin of the strains of the larch sawfly, *Pristiphora enchsonii* in North America (Hymenoptera: Tenthredinidae).

3. Continue work on the revision of the genus *Pristiphora*.

15. Publications:

Up to 1973-74

Lejeune, R.R. and H.R. Wong. 1949. Distribution of larch sawfly in Manitoba and Saskatchewan. Canada, Dept. Agric, For. Biol. Div., Bi-monthly Prog. Rept. 5(6): 2.

Wong, H.R. 1950. Sawfly larvae of the subfamily Nematinae attacking conifers in the forests of the Canadian Prairies. Master thesis. Michigan State University: 1-33.

Wong, H.R. 1951. Cocoons of some sawflies that defoliate forest trees in Manitoba and Saskatchewan. Ann. Rept. Ent. Soc. Ontario. 82: 62-67.

Wong, H.R. 1954. Common sawflies feeding on white birch in the forested areas of Manitoba and Saskatchewan. Can. Ent. 86: 154-158.

Wong, H.R. 2955. Nearctic larvae of the genus *Anoplonyx* (Tenthredinidae: Hymenoptera). Can. Ent. 87: 224-227.

Wong, H.R. 2956. Preliminary notes on intersexes and gynandromorphs of the larch sawfly. Can. Ent. 88: 545.

Wong, H.R. 1956. Common *Tenthredo* larvae feeding on deciduous trees in the Canadian Prairies (Tenthredinidae: Hymenoptera). Interim Rept. Forest Biology Lab: 19-25.

Wong, H.R. 1957. Sawflies of the genus *Platycampus* Schiodte on trembling aspen in the Canadian Prairies. Canada, Dept. Agric., For. Biol. Div., Bi-monthly Prog. Rept. 13(4): 2.

Wong, H.R. 1958. The morphology of the adult of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Tenthredinidae: Hymenoptera). Interim Rept. Forest Biology Lab., Winnipeg 1958-1: 1-43.

Wong, H.R. 1958. The morphology of the ultimate larval instar of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Tenthredinidae: Hymenoptera). Interim Rept., Forest Biology Lab., Winnipeg 1958-1: 1-16.

Wong, H.R. 1960. Evolution of the sawfly genus *Pristiphora* Doctor of Philosophy in Entomology Thesis. University of Illinois: 1-113.

Wong, H.R. and H.H. Ross. 1960. New Nearctic species of the genus *Pristiphora* Latreille (Hymenoptera: Tenthredinidae) Can. Ent. 92(3): 193-1.

Wong, H.R. 1960. Evolution of the sawfly genus *Pristiphora* Diss. Abs. 21(6): 1676.

Wong, H.R. 1963. The external morphology of the adults and ultimate larval instar of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Hymenoptera: Tenthredinidae). Can. Ent. 95: 897-921.

Wong, H.R. and R.B. Benson. 1965. A new species of *Pristiphora* from Brazil (Tenthredinidae: Hymenoptera). Can. Ent. 97(7): 779-782.

Wong, H.R. 1966. A new species of *Allantus* Panzer on birch (Hymenoptera: Tenthredinidae) Can. Ent. 98(8): 852-854.

Wong, H.R. 1967. The Namatine genera *Eitelius* and *Micronematus* in North America (Hymenoptera: Tenthredinidae). Can. Ent. 99: 1101-1104.

Wong, H.R. 1968. *Decanematus*, a sawfly genus new to North America (Hymenoptera: Tenthredinidae). Can. Ent. 100(1): 84-86.

Wong, H.R. 1968. *Pristiphora gelida*, a new species from Alaska (Hymenoptera: Tenthredinidae) J. Nat. Hist. 2: 185-186.

Wong, H.R. 1968. A revision of the tribe Pristolini (Hymenoptera: Tenthredinidae) Can. Ent. 100: 1049-1057.

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

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

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

Wong, H.R. 1972. The spread of the European spruce sawfly *Diprion hercyniae* (Hymenoptera: Diprionidae) in Manitoba. Can. Ent. 104: 755-756.

Wong, H.R. and H.E. Milliron. 1972. A Canadian species of *Susana* on western juniper (Hymenoptera: Tenthredinidae) Can. Ent. 104: 1025-1028.

1973-74

Nil.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 089

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 29, 1974

1. Project: Detection and appraisal of tree pests and vegetative disturbances.

2. Title: Analysis and synthesis of Forest Insect and Disease Survey historical data and information.

3. New: Cont.: X 4. No.: NOR 089

5. Study Leader: W. G. H. Ives

6. Key Words: Population trends, computer mapping, data retrieval, insects and environment.

7. Location of Work: Edmonton and Ottawa

8. Problem:

The large body of data collected by the Forest Insect and Disease Survey since its inception has never been thoroughly examined to determine what information it contains regarding population trends and the environment.

Some of the data on general distribution and abundance and on rates of parasitism were in reports or on raw data sheets, but had not been transferred to forms suitable for computer input. Similarly, the format used by the Meteorological Branch of the Department of Transport for summarizing their weather data was not suitable for some of the analyses, and additional summaries had to be prepared.

This study has undertaken to consolidate all of the available information on common insects and weather records for Manitoba and Saskatchewan into a format suitable for computer input, and to subject these data to a thorough examination. Writing of the necessary computer programs will be undertaken by staff in Ottawa.

9. Study 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.

10. Resources:

a. Starting date: 1969
b. Estimated year of completion: Indefinite Revised: I 1974 II 1976
c. Estimated total Prof. man-years required: 3
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. W. G. H. Ives .3
Supp. .5
Casual Nil
Total .8 O & M funds req'd: $500

11. Progress to Date:

Annual infestation histories (1945 to 1968) for 11 of the most common forest insects in Manitoba and Saskatchewan have been mapped, the data transferred to special forms and then recorded on punch cards and edited. Parasite rearing or dissecting records for 15 of the more common forest insects have been transferred to specially designed forms suitable for computer input, and the data key punched and edited. Temperature and precipitation data from the Monthly Record have been transferred to special forms, key punched and edited.

Requests for the writing of a number of computer programs to summarize the above data were submitted to Ottawa.

The numbers of heat units during a fixed overwintering period and a shifting early larval feeding period for the forest tent caterpillar, *Malacosoma disstria* Hbn., were calculated from official weather data and related to known infestations or outbreaks of this insect in the Prairie Provinces and Ontario. Years with increasing populations had cooler overwintering periods and warmer early feeding periods than did those with decreasing populations. A single year with a relatively cool winter and an unusually warm spring occurred two to four years before the first reported defoliation for all known infestations at each of 10 weather stations. Most population collapses were accompanied by cool springs and some by warm winters. The same general pattern prevailed for infestations in southern Ontario, when compared with the number of heat units at Toronto for the period 1860 to 1969. Favorable temperatures are therefore believed to be primarily responsible for triggering the onset of outbreaks of the forest tent caterpillar, and unfavorable temperatures are believed to be a major factor in their termination. The results should aid in predicting when and where outbreaks are likely to occur.

12. Goals for 1973-74:

1. To consult with programmers in Ottawa and have them develop the necessary programs for providing the computer summaries first requested in 1970.

2. If forthcoming, to use these summaries in preliminary investigations of population trends for some of the more common insects.

3. To investigate the relationships between published records of spruce budworm outbreaks and heat units or other expressions of temperature, and to publish the results if the analyses proceed favorably.

13. Accomplishments in 1973-74:

1. Despite assurances from Ottawa that FIDS programming requirements were being given a higher priority than of late, no summaries have yet been prepared. An additional programmer has apparently been assigned to work with McManus, so hopefully something will be forthcoming in the coming year.

2. No summaries were received, so nothing could be done.

3. Outbreaks of the spruce budworm were found to be related to heat units above various thresholds. The numbers of heat units above 40° F from September 15 to estimated emergence and below 0° F from October 1 to May 1 tended to be lower for years with increasing populations than for years with decreasing populations than for years with decreasing populations, when pairs of years for infestations at a number of stations were compared. On the other hand, the numbers of heat units above 50°F for a 6-week period following the estimated date of peak third-instar were higher for increasing populations than for decreasing populations. Calculation of these variables (plus rainfall for the same 6-week period as above) over a 40-year period at a number of stations, showed that weather conditions before and during outbreaks tended to be more favorable than during non-outbreak periods.

   A manuscript was prepared and submitted for local and outside review. One of the outside reviewers was extremely critical, saying that nothing new had been added to the literature. His main reason for criticism was his refusal to accept less than the traditional level of significance, which I had done for the first two variables mentioned. Another reviewer suggested that I extend the overwintering period to include spring heat units before emergence.

   The first of these criticism was, I think, overcome by the addition of extra infestations, and the second was accepted as a valid suggestion. However, both changes involved a large amount of calculations, which are now complete, and extensive revision of figures and text. This should be completed by this spring, unless there are additional delays due to reviewer comments.

14. Goals for 1974-75:

1. If not already finished, complete the manuscript on weather and outbreaks of the spruce budworm.

   Proposed title: Weather and Outbreaks of the Spruce budworm, *Choristoneura fumiferana (Lepidoptera: Tortricidae)*.

2. Begin preliminary investigation of possible relationships between weather and other defoliating insects. Possible candidates are the large aspen tortrix, the jack pine budworms and the larch sawfly.

3. Any work with the historic file and ancillary data held in Ottawa will depend entirely on what progress is made in preparing the summaries requested in 1970. If no progress is made during the coming year, I feel that the data should be transferred to NFRC.

15. Publications:

Up to 1973-74

Nil.

1973-74

Ives, W. G. H. 1973. Heat units and outbreaks of the forest tent caterpillar, *Malacosoma disstria (Lepidoptera: basiocampidae)*. Can. Ent. 105:529-543. (Listed as *In Press* last year).

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 110

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 29, 1974

1. Project: Detection and estimation of tree pests and vegetative disturbances.

2. Title: Dutch elm disease detection and diagnosis.

3. New: Cont.: X 4. No.: NOR 110

5. Study Leader: V. Hildahl

6. Key Words: Entomology, pathology, detection, appraisal, insect control, disease control, tree species.

7. Location of Work: Manitoba

8. Problem:

Nature of Study:

Dutch elm disease is a potential and serious hazard to elms in the prairie sections of the Region. The pathogen was first discovered about 1933 in the northeastern United States. Since then it has spread north and eastward into Canada and westward in the United States to Idaho and Colorado. At the present time it has affected about 80 per cent or more of the natural range of American elm in North America. In 1973, the pathogen was positively diagnosed from dying American elms on the University Campus at Fargo, North Dakota. The discovery of the disease in this area is of importance to Manitoba because it places the disease approximetely 60 miles nearer and definitely establishes it in the Red River Valley. In areas where the disease has been prevalent for several years, the host tree has been practically eliminated. How severely elms will be affected in southern Manitoba (and the prairie sections) is difficult to predict, but if the impact is as great as it has been in the areas outlined above the economic and aesthetic loss would be incalculable.

Benefits of Study:

Major benefits of the study will be to maintain the aesthetic values and pleasant environments associated with American elms in rural, urban and park areas; which would otherwise be completely destroyed. In many urban centres (including Winnipeg) throughout the prairie region American elm represents up to 80 per cent of the tree cover.

Probability of Success:

Early detection of the disease can keep losses of American elms within tolerable limits. This has been demonstrated in areas where adequate sanitation programs were established when the pathogen was first discovered tree losses have been kept to 1 to 2 per cent per year.

Methods Used:

Suspect trees are sampled, and material subsequently cultured under laboratory conditions and techniques for determination of causal organism. In conjunction with ground sampling programs the use of low level aerial photography (infrared) has been proposed for parts of the Red River Valley in Manitoba in 1974. Results of the aerial photography will be used primarily to: 1. expedite detection of suspect trees leading to early diagnosis of the pathogen in southern Manitoba; 2. provide a continuous permanent record pertaining to the condition of American elm stands along the Red River; and 3. develop an inventory of elms in high hazard areas.

9. Study Objectives:

Study objectives are primarily: 1. to carry out systematic detection and diagnostic services leading to early discovery of the Dutch elm disease in the Region; and 2. provide technical guidance and assistance to provincial, municipal and urban governments with respect to control techniques if and when the disease is detected in the province. An important advisory function pertaining to the Dutch elm disease study is serving as a member on a Provincial Advisory Committee on Tree Protection established by the Minister of Agriculture.

10. Resources:

a. Starting date: 1970
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof.
Supp. .3
Casual .2
Total .5 O & M funds req'd:

11. Progress to Date:

From 1970 to 1972 the Dutch elm disease programs involved both ground and aerial reconnaissance. Detection surveys were conducted along all river valleys, and in urban centres and rural areas where major concentrations of American elm occur. More than 3,000 suspect trees (trees with characteristic external symptoms - flagging, dead branches of die back in the crown) were sampled, of which 35 per cent

showed evidence of peripheral stain of the wood. Laboratory diagnosis of material from these trees has indicated widespread infections of *Fusarium* wilt, *Verticillium* wilt, and occasional occurrence of *Cephalosporium* wilt. The fungus, *Ceratocystis ulmi* which causes Dutch elm disease has not been isolated from sample material in southern Manitoba to date.

In 1972-73, approximately 325 unhealthy, dying and dead American elms, reported by private individuals or detected on routine surveys, were examined. Of the trees examined, 120 required laboratory diagnosis to determine causal agent. Additional diagnostic services were carried out on 190 trees sampled or reported by cooperating agencies, and technical advice provided with respect to recognizing disease symptoms and treatment of affected trees.

12. Goals for 1973-74:

1. Continue detection surveys in the southern part of the province, and provide diagnostic services as required for cooperating agencies.

2. Implement proposed aerial infrared and color photography programme relative to Dutch elm disease detection. This programme to involve complete aerial coverage of the Red River Valley in a test area 2 x 10 miles from St. Norbert to Glenlea at scales of 1:1,000 and 1:3,300.

3. Publish an Information Report including all Dutch elm disease investigations to date in Manitoba.

13. Accomplishments in 1973-74:

1. Detection surveys were continued along the Red, Assiniboine, and Pembina watersheds, and diagnostic services provided for samples submitted by cooperating agencies. Approximately 500 trees were examined and material taken from 78 for laboratory culturing. Diagnosis is continuing on three suspect samples taken (two from the town of Selkirk and one from the city of Winnipeg) because of the similarity of the cultures to *C. ulmi*.

2. The proposed aerial photography using infrared and color film was implemented along the Red River but the programme was altered to meet more specific requirements. Two scales of photography were obtained as follows: high-level photography was taken of the area from Winnipeg to Emerson at 10,000' AGL using a 3" lens and low-level photography from St. Norbert to Glenlea at 1,000' AGL using a 12" lens. The processed high-level photography was received in early August and the low-level in late August. Approximately 20 man-days were spent plotting and ground truthing the photography prior to first fall frosts (about September 10), and preliminary indications are that trees exhibiting unhealthy symptoms can be recognized. Similarly, defoliated as well as dead trees can be readily detected on both infrared and color

photography. The aerial photography was carried out by the Remote Sensing Group, Northern Forest Research Centre.

3. The Information Report is only in its earliest stages of preparation due to other priorities.

14. Goals for 1974-75

1. Continue detection surveys in American elm stands throughout southern Manitoba, and provide diagnostic services as required for cooperating agencies.

2. Continue ground truthing of aerial photography (both high-level and low-level) in 1974.

3. Complete Information Report entitled "Dutch elm diseases of elm in Man.

4. Provide technical advisory services to provincial and municipal governments, particularly in relation to sanitation practices recommended for reducing the impact of Dutch elm disease (the province of Manitoba and city of Winnipeg are currently initiating a programs of sanitation to remove all dead and dying American elm wood along the Red River south for a distance of 5 to 10 miles.

15. Publications:

Up to 1973-74

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

1973-74

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 114

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 19, 1974

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Symptomology of atmospheric effluent effects on the forest (slightly changed from 1973-74).

3. New: Cont.: X 4. No.: NOR 114

5. Study Leader: D. Hocking

6. Key Words: Sulphur gases, vegetation, lodgepole pine, white spruce.

7. Location of Work: Region-wide.

8. Problem:

Industrial effluents discharged into the atmosphere in a number of locations have a real, imagined, or potentially deleterious effect upon adjacent trees and other plant life. Government agencies and the general public at all levels are expressing concern. Industrial groups are apprehensive as to restrictions which may be applied. Regulatory agencies in many instances lack essential scientific information describing cause and effect relations. Provincial government agencies, industry and the public request involvement by the Canadian Forestry Service in this environmental problem in the form of cooperative research programmes, detection and assessment surveys, and advisory services.

9. Study Objectives: (some objectives from 1973-74 transferred to other studies)

a. Describe macro and micro symptoms on forest vegetation resulting from known amounts of single and combined (synergistic) atmospheric industrial effluents.

b. Define the event sequence in which symptoms are produced.

c. Develop diagnostic techniques based on specific symptoms.

d. Discern injury thresholds under different environmental conditions.

e. Develop a species sensitivity index for different environmental conditions.

f. Define the environmental conditions and sequences leading to species sensitivity.

g. Define predispositional results of pollutants.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: Revised: 1980
c. Estimated total Prof. man-years required: 40
d. Essential new major equipment items for 1974-75 with costs:
SO_2 monitor $12,000
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years

Prof.	0.7	(Hocking	0.3)
		(Malhotra	0.2)
		(Blauel	0.2)
Supp.	0.7	(Fenn)	
Casual	0.3		
Total	1.7		

0 & M funds req'd:

11. Progress to Date:

Good relations and cooperative working arrangements have been established with Provincial and Federal Government agencies involved with air pollution problems and with industry and the public in the field. The Canadian Forestry Service is regarded within the region as an important contributor of information relating to air pollution effects on vegetation.

Permanent sample plots have been located and vegetation described, in vicinity of gas processing plants and oil sands processing plants; including plume impingement areas.

A growth chamber has been designed with sophisticated equipment and controls specifically for air pollutant studies. Delivery is expected in March, 1974.

12. Goals for 1973-74:

1. Complete bench marking of lichen populations, ground vegetation, and trees in permanent monitoring plots.

2. Locate plume impingement areas in vicinity of Aquitaine plant.

3. Set up fumigation chamber and run trials.

4. Determine effect of pH of aqueous solutions of sulphur dioxide on foliar tissues.

13. Accomplishments in 1973-74:

1. Permanent monitoring plots in the Rocky Mountain House and Fort McMurray area were documented by detailed color photography and by sample collection. Further work on this aspect is now transferred to Study NOR

2. Plume impingement areas near the Aquitaine Gas Plant were studied by contract (Study NOR 7 710). Final report is awaited.

3. Fumigation chamber was designed and ordered (Colmat, Vancouver).

4. Study of the effects of aqueous solutions of SO_2 on foliage was suspended owing to resignation of staff; is now transferred to Study NOR

5. An industry-government workshop was sponsored in cooperation with the Research Secretariate of the Alberta Department of the Environment. Good working contacts were made, extended or strengthened. Proceedings were published.

6. The herbarium and color slide reference collections were expanded.

14. Goals for 1974-75:

1. Set up, stabilize and calibrate air pollutant chamber.

2. Run exploratory trials to "shake-down" chamber performance.

3. Run detailed experiments on one species at one set of environmental conditions.

4. Attempt further field fumigations.

15. Publications:

Up to 1973-74

Loman, A. A. 1972. Atmospheric sulphur dioxide and foliar sulphur content. NOR-Y-48.

Loman, A. A., R. A. Blauel and D. Hocking. 1972. Sulphur dioxide and forest vegetation. NOR-X-49.

Blauel, R. A. 1972. Comments on vegetation section of the Canadian Petroleum Association submission to the Environment Conservation Authority, Alberta Department of the Environment, Edmonton. NOR-Y-73.

Baluel, R. A. 1973. Intervention by CFS-EPS on application by Gulf Oil for exemption from minimum sulphur recovery

efficiency guidelines of the Energy Resources Conservation Board, Government of Alberta. January 5, 1973. File Report.

1973-74

Hocking, D. and D. Reiter (Eds.) 1973. Proceedings of a workshop on sulphur gas research in Alberta. NOR-X-72 21 papers.

Hocking, D. 1973. Some terms for symptoms on plants exposed to sulphur gases. In: NOR-X-72.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 970

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 19, 1974

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on forest soils.

3. New: X Cont.: 4. No.: NOR 970

5. Study Leader: J. Baker

6. Key Words: Soil profile, soil horizons, grey wooded soils, phosphate absorption, ammonium-nitrogen, sulphur compounds, air pollution, heavy metals.

7. Location of Work: Region wide.

8. Problem:

Nature of Study:

This study is necessitated by the fact that industrial operations emit various compounds into the atmosphere. These compounds react with the total environment and have the potential of causing serious damage.

The proposed study will concentrate in the first instance on the effects of sulphur emissions on soil characteristics. In addition to the direct effects of these emissions on the total and available forms of sulphur in the soil, attention also will be given to those transformations of an indirect nature.

Benefits expected:

Agencies, concerned with the potential hazards of air pollutants on the environment frequently lack essential scientific information describing cause and effect relationships. Information obtained from this study should prove beneficial in assessing both the immediate and long term hazards to the soil environment.

Probability of success and practical application:

Regardless of how the results of this study are evaluated and interpreted, success seems assured. If results show positive adverse effects of atmospheric sulphur pollutants on the soil environment, then regulatory agencies will be in possession of additional essential information to set meaningful and safe limits on levels of atmospheric pollutants. On the other hand, if there are no real serious threats to the soil, any previous apprehension, on the part of the various interested agencies, may be dismissed.

Methods used:

There will be both laboratory and field work associated with this study. In the laboratory, soil columns composed of the essential horizons from unexposed soil material will be subjected to known total amounts of sulphur dioxide. These soil columns will then be leached with water and percolate analyzed for changes in various chemical constituents. In addition, the leached soil solids will be analyzed for these chemical constituents. The field work will mainly involve sampling soil at various stations within and without the sulphur impingement area. The field work will mainly be used for studying long term effects of pollutants on the soil from sites in close proximity to industrial operations.

9. Study Objectives:

To determine the influence of air pollutants, in the first instance sulphur dioxide gas on the soil equilibrium. Detailed emphasis will be placed upon modifications in the chemical constituents in the soil both as to amount or form and to the region of accumulation in the soil profile. Effects of sulphur on the soil micro-flora, i.e., sulphur and nitrogen organisms, will be studied. Changes in sulphur availability in the soil and the effect of this on sulphur up-take also will be investigated.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 0.8
d. Essential new major equipment items for 1974-75 with costs:

Atomic absorption spectrophotometer	$15,000

e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years

Prof.	0.4
Supp.	0.5
Casual	0.3
Total	1.2

O & M funds req'd:

11. Progress to Date:

Nil. New Study.

12. Goals for 1973-74:

Nil. New study.

13. Accomplishments in 1973-74:

Nil. New study.

14. Goals for 1974-75:

Installation of sampling sites will be completed at Aquitaine and a further six sites will be developed at Fort McMurray. Additional control sites (2) will be established at Aquitaine. A sampling site will include:

1) Collection of through fall precipitation
2) Collection of gross fall precipitation
3) Collection of stem flow precipitation
4) Collection of litter fall (debris)
5) Installation of ceramic water samplers at the base of test trees
6) Installation of Pb O_2 plates at several levels in test trees to estimate cumulative SO_2 impingement
7) Establishment of soil sampling sites
8) Analysis of soil solution and solids including survey of N and S organisms in soil

15. Publications:

Up to 1973-74

Nil

1973-74

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 974

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 19, 1974

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on biochemical processes of the forest vegetation.

3. New: X Cont.: 4. No.: NOR 974

5. Study Leader: S. S. Malhotra, D. Hocking

6. Key Words: Photosynthetic fixation, lodgepole pine, photosynthetic pigments, aqueous sulphur dioxide, Na $H^{14}CO_3$, biomass, spectrophotometry, pigment metabolism, *in vivo*, *in vitro*.

7. Location of Work: Northern Forest Research Centre and University of Alberta, Edmonton.

8. Problem:

One of the major concerns in industrialized areas is the emission of effluents into the atmosphere. Most of these effluents have a great potential to cause irreversible damage to forest trees and other vegetation. Since there is not enough information available either on direct or indirect effects of air pollutants on plant life, regulatory agencies have difficulty in applying any meaningful and effective restrictions.

Sulphur dioxide is the principal atmospheric pollutant in many industrial areas. Research on this gas has been mostly limited to physiological studies (work with intact tissues) and description of the necrotic symptoms which develop on plant leaves. The mechanism of SO_2 toxicity at molecular level has not been examined in detail. An understanding of the biochemical mechanism of SO_2 toxicity in forest species would help to explain their pollution sensitivity and would provide information on the effects (positive or negative) of low levels of sulphur dioxide on biomass production. The regulating agencies when supplied with this vital information will be in a better position to set more rational levels of SO_2.

Since SO_2 has been shown to cause discoloration of leaves, we will examine the effects of SO_2 on the photosynthetic fixation of $^{14}CO_2$

by lodgepole pine seedlings, and investigate the interaction between this gas and photosynthetic pigments extracted from forest trees.

9. Study Objectives:

To determine the effects of SO_2 on some of the central biochemical processes in forest species.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 1.8
d. Essential new major equipment items for 1974-75 with costs:
2 waterbaths
ice machine
Biological O_2 monitor $5,000
e. Essential new major equipment items beyond 1975 with costs:
Ultracentrifuge $15,000
f. 1974-75 man-years Prof. 1.1 (Malhotra 0.8, Hocking 0.3)
Supp. 0.7
Casual
Total 1.8 O & M funds req'd:

11. Progress to Date:

Nil. New study.

12. Goals for 1973-74:

Nil. New study.

13. Accomplishments in 1973-74:

Nil. New study.

14. Goals for 1974-75:

To determine SO_2 effects on the photosynthetic activity of lodgepole pines, the following will be done:

a. The plant material will be treated with known concentrations of aqueous SO_2, incubated with $NaH^{14}CO_3$, and allowed to photosynthesize for different lengths of time under known environmental conditions. After the treatment, the rate of photosynthesis will be determined from the amount of radio-activity incorporated into the products of photosynthesis.

b. Pigments from pine seedlings will be exposed to aqueous SO_2 *in vivo* and *in vitro*. The various pigments will be extracted from treated and untreated plants and changes in pigment metabolism will be determined by means of spectrophotometry. This study (b) will be carried out in co-operation with

Dr. C. T. Phan, Department of Plant Science, University of Alberta, Edmonton.

15. Publications:

Up to 1973-74

Nil

1973-74

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 978

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 19, 1974

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on sub-cellular structure of forest vegetation.

3. New: X Cont.: 4. No.: NOR 978

5. Study Leader: S. S. Malhotra

6. Key Words: Sub-cellular structural organization, necrotic symptoms, electron microscopic analysis, aqueous sulphur dioxide, fixation, staining.

7. Location of Work: Northern Forest Research Centre and University of Alberta, Edmonton.

8. Problem:

Sulphur dioxide is one of the most toxic constituents of polluted air. It has a great potential to cause irreversible damage to forest trees and other vegetation. Since there is not enough information available either on direct or indirect effects of SO_2 on plant life, regulatory agencies have difficulty in applying any meaningful and effective restrictions. Studies on this gas have been mostly limited to acute or chronic injuries. Low concentrations of SO_2 that do not produce any visible symptoms (before chronic injury symptoms) may affect growth by interfering with the sub-cellular structure.

The mechanism of SO_2 action at the level of sub-cellular structure has not been studied in detail. At low concentrations, the effects of SO_2 on vegetation may be due to (a) interference with some of the biochemical processes in plants, (b) interference with the sub-cellular structural organization, (c) combination of (a) and (b). Integrated studies comprising biochemical (Study-7-974) and electron microscopic analysis would help to explain the effects of low levels of SO_2 on biomass production. The regulatory agencies when supplied with this vital information will be in a better position to set more rational levels of SO_2.

9. Study Objectives:

To determine the effects of SO_2 on sub-cellular organization and relate these results with those obtained by the biochemical studies (Study NOR-7-974).

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 0.4
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.2
Supp. 0.3
Casual --
Total 0.5 O & M funds req'd: $540

11. Progress to Date:

Nil. New study.

12. Goals for 1973-74:

Nil. New study.

13. Accomplishments in 1973-74:

Nil. New study.

14. Goals for 1974-75:

To determine the effects of various concentrations of SO_2 on sub-cellular structure of forest species. The plant material will be treated with aqueous SO_2 and fixed glutaraldehyde. After fixation the material will be washed with phosphate buffer, dehydrated through a graded series of ethanol solutions and embedded in Araldite. Thin sections will be stained in uranyl acetate, followed by lead citrate before examination under the electron microscope. This study (electron microscopic work and interpretation of results) will be carried out in co-operation with Dr. S. K. Malhotra, Director of Electron Microscopy Laboratory, University of Alberta, Edmonton.

15. Publications:

Up to 1973-74

Nil

1973-74

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 979

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 19, 1974

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: The fate of atmospheric sulphur compounds.

3. New: X Cont.: 4. No.: NOR 979

5. Study Leader: D. Hocking

6. Key Words: Air pollution, sulphur dioxide, hydrogen sulphide, isotope partitioning, acid precipitation.

7. Location of Work: Region-wide.

8. Problem:

Industrial effluents discharged into the atmosphere in a number of locations have a real, imagined, or potentially deleterious effect upon adjacent trees and other plant life. Government agencies and the general public at all levels are expressing concern. Industrial groups are apprehensive as to restrictions which may be applied. Regulatory agencies in many instances lack essential scientific information describing cause and effect relations. Provincial government agencies, industry and the public request involvement by the Canadian Forestry Service in this environmental problem in the form of cooperative research programmes, detection and assessment surveys, and advisory services.

Of particular concern to regulatory agencies is the potential long-term effect of atmospheric emissions. Predictions of long-term effect depend on an accurate and detailed understanding of the fate of the emissions: where do they go?

9. Study Objectives:

a. Develop and apply methods for measurement of atmosphere-borne sulphur compounds wherever they are removed from the atmosphere: by settle-out, by precipitation, and by active assimilation.

b. Using data from (a) above, develop and refine a "sulphur budget" for an individual source of emissions.

c. Apply "sulphur budgeting" to other sources for which data are available or can be gathered.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 4
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years

Prof.	0.4	(Hocking, 0.3)
		(Baker, 0.1)
Supp.	0.5	(Ridgway 0.5)
Casual		
Total	0.9	0 & M funds req'd:

11. Progress to Date:

Plots have been established for the measurement of sulphur "settling-out" and in rainfall near the Aquitaine Ram River gas plant and the GCOS plant near Fort McMurray, in cooperation with Dr. M. Nyborg (Soil Science, University of Alberta). A sampling programme has been initiated for the partitioning of atmosphere and soil contributions to sulphur in vegetation. Separation is by characteristic stable isotope proportions determined by mass spectrometry, in cooperation with Dr. R. Krouse (Physics, University of Calgary).

12. Goals for 1973-74:

Nil. New study.

13. Accomplishments in 1973-74:

Nil. New study.

14. Goals for 1974-75:

1. Continue collection of precipitation and settle-out data.

2. Establish further plots in the Fort McMurray area.

3. Analyze vegetation, soil, and atmospheric sulphation plate samples from around Aquitaine for isotope proportions.

4. Collect similar samples from the Fort McMurray area.

15. Publications:

Up to 1973-74

Nil

1973-74

Baker, J., D. Hocking and M. Nyborg. 1973. Effect of atmospheric sulphur dioxide on the pH of rain intercepted by forest trees. In: Hocking and Reiter (Eds.) Proceedings of a workshop on sulphur gas research in Alberta. NOR-X-72.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 029

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1974

1. Project: Reduction of damage from disease causing agencies.

2. Title: Biology and epidemiology of dwarf mistletoe on lodgepole and jack pine.

3. New: Cont.: X 4. No.: NOR 029

5. Study Leader: J. A. Muir

6. Key Words: *Arceuthobium americanum, Pinus contorta, Pinus banksiana,* detection, damage, spread, infection, parasites, control.

7. Location of Work: Boreal Forest and Rocky Mountain Range.

8. Problem:

Dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.), a seed plant which is parasitic on conifers, is widespread but sporadic, and occasionally causes severe damage to lodgepole pine and jack pine in western Canada. Generally, sufficient information is on hand for effective management of dwarf mistletoe on lodgepole pine appropriate to current management intensities, but very little is known of dwarf mistletoe epidemiology and biology on jack pine. Methods are needed for extensive surveys to detect and appraise infestation by dwarf mistletoe. A low-level aerial detection survey was developed recently for infested jack pine forests. For jack pine, damage caused by dwarf mistletoe is known in general terms, and in some areas of intensive management a detailed study may be required to relate damage to infestation, tree age and site quality. In high-use areas such as campgrounds, the hazards of dwarf mistletoe infested trees are unknown. Particularly large witches brooms which appear subject to wind breakage are formed on infested jack pine. Reasons for the formation of such large brooms on jack pine are unknown, and large brooms may be related to the apparently greater damage by mistletoe on jack pine than lodgepole pine.

Effective control of dwarf mistletoe infestation can be obtained by extensive clearcutting and destruction of all infested trees. However, alternative control methods are needed for situations where clearcutting is aesthetically or otherwise unacceptable, where

infestation occurs in small areas, and where individual infested trees need treatment. For effective control treatments and a basis for judging the priority of situations for control treatment, specific epidemiological information, such as the rate of spread of infestation, is needed for dwarf mistletoe on jack pine. Areas where dwarf mistletoe is reportedly absent, such as forest zone B19a investigated to determine possible natural control of infestation and risks of infestation particularly in relation to management practices.

9. Study Objectives:

1. Determine and demonstrate methods for extensive surveys of dwarf mistletoe infestation.

2. Determine impact (damage) and spread of dwarf mistletoe on jack pine.

3. Determine methods to control infestation of jack pine.

4. Continue and complete previously established studies of dwarf mistletoe epidemiology on lodgepole pine.

10. Resources:

a. Starting date: 1962
b. Estimated year of completion: 1973 Revised: 1975
c. Estimated total Prof. man-years required: 2.0
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 1.0
Supp. 1.0
Total 2.0

11. Progress to Date:

Aspects of the biology and epidemiology of dwarf mistletoe in young lodgepole pine that have been determined include: rate of increase of infestions; occurrence and spread of infections in relation to density of infection sources; timing, rate and distance of seed dispersal; biology of seed germination; and identification and effects of fungal parasites of dwarf mistletoe. An extensive study of the development of infections from naturally and artificially inoculated seed was established and continued. Progress to 1968 was summarized in three internal reports.

In 1972 the study was expanded to include dwarf mistleton on jack pine. Literature was reviewed, and field conditions in Manitoba, Saskatchewan and Alberta were examined. An extensive survey of infestation of jack pine was conducted in northeastern Alberta and results were plotted on the clients maps. Distinctive maps of dwarf

mistletoe infestation on aerial photographs were found and reported, and a proposal for remote sensing of infestation was accepted by the Canadian Centre of Remote Sensing.

12. Goals for 1973-74:

1. Publications and reports:

a. Epidemiology of lodgepole pine dwarf mistletoe in southern Alberta and implications for control (proposed).

b. Status of dwarf mistletoe of jack pine (proposed).

c. Dwarf mistletoe on jack pine (proposed For. Pest Leaflet).

d. *Cylindrocarpon gillii*, a new combination for *Septogloeum gillii* on dwarf mistletoes (reviewed).

e. Detection of dwarf mistletoe infestation centres in jack pine on aerial photographs (reviewed).

f. Low-level aerial survey of dwarf mistletoe infestation of jack pine (proposed).

g. Incidence of dwarf mistletoe in a young lodgepole pine forest (to be revised or incorporated with (a) above).

2. Continue observations and anlysis of development of dwarf mistletoe infections on lodgepole pine.

3. Complete observations of dwarf mistletoe seed dispersal on lodgepole pine.

4. Demonstrate low-level aerial survey technique for management agencies.

5. Evaluate conventional and small-scale aerial photographs for detecting dwarf mistletoe infestation of jack pine.

13. Accomplishments in 1973-74:

1. Reports d and e were published, and g is being reviewed. Reports a, b and c were deferred until reports of previous work on lodgepole pine are completed. Report f is junior authorship with J. Robins

2. Dwarf mistletoe infections were examined and photographed. Further observations were made of infection mortality, limited shoot and berry production on many infections, and differences in growth on different sites. Preliminary analyses of data revealed that new infections produced berries sooner than

previously reported in Colorado,

3. Complete observations of dwarf mistletoe seed diagnosed on lodgepole pine.

4. Demonstration was postponed until report of technique is prepared.

5. Conventional aerial photographs were compared with results of low-level aerial survey. Stand openings were associated with most infested forests, but openings not caused by infestation were also found. A preliminary key was made to distinguish stand openings caused by infestation. Colour aerial photography in the study area was not obtained by the Canadian Centre of Remote Sensing because of poor visibility.

14. Goals for 1974-75:

1. Complete the following reports and work on dwarf mistletoe of lodgepole pine:

   a. Dwarf mistletoe infection sources and infestation of young lodgepole pine. Phytopathology.

   b. Occurrence and effects of *Colletotrichum gloeosporiodes* on dwarf mistletoe in young lodgepole pine. Canadian Journal of Forest Research.

   c. Lodgepole pine dwarf mistletoe: seed dispersal and germination. Canadian Journal of Forest Research or Canadian Journal of Botany.

   d. Analyze and report observations of development of dwarf mistletoe infections from seed.

2. Other reports:

   Low-level aerial survey of jack pine dwarf mistletoe (co-authorship with J. Robins). Information Report.

3. Conduct a review and problem analysis for dwarf mistletoe of jack pine.

4. Obtain and evaluate small-scale colour and colour infra-red photographs for detecting dwarf mistletoe infestation of jack pine.

15. Publications:

Up to 1972-73

Journal publications:

Muir, J.A. 1973. *Cylindrocarpon gillii*, a new combination for *Septogloewm gillii* on dwarf mistletoe. Can. J. Botany 51. In Press.

Muir, J.A. and J.K. Robins. 1973. Detection of dwarf mistletoe of jack pine on aerial photographs. Plant Disease Reporter 57(11). In Press.

Muir, J.A. 1973. Aerial photographs used to detect infestation of jack pine forests by dwarf mistletoe. Proc. 21st Western Int. Forest Disease Work Conf. Estes Park, Col. October 2-5. In Press.

Departmental publications

Muir, J.A. 1973. Lodgepole pine dwarf mistletoe on Douglas fir in Alberta. Bi-Mon. Res. Notes 29:25-26.

Muir, J.A. 1973. Dwarf mistletoe damage. Forestry Report. Northern Forest Research Centre 3(3):8.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1974

1. Project: Reduction of damage from disease causing agencies.

2. Title: Reduction of losses from canker and dieback.

3. New: Cont.: X 4. No.: NOR-044

5. Study Leader: H. Zalasky

6. Key Words: Frost burl, frost canker and dieback, bark pitch pocket, low temperature, hyper- and hypoplasia, interlocking and spiral grain, brachiate tracheids, sclereid-like cells, scabby bark, conifers, hardwoods.

7. Location of Work; Region-wide.

8. Problem:

Studies of distribution of hosts and geographic distribution and the histology of the bark and wood damage by low temperature was undertaken in 1971 to define the impact and symptoms on trees of different species. Investigations included annual rejuvenating capability, development and maturation of still-living woody tissues in annual growth rings around the frost canker, and freeze-killing of new abnormal tissues. In frost hollows and frost risk localities, frost cankers are perennial because of the annual monthly or seasonal pattern of freeze-thaw conditions. Freeze-thaw is defined as a drastic variation between the high temperature during the day, the low of the night and the high of the next day regardless of season or month of the year. The range in which diurnal temperatures are required to drop from a high to a low and rise again to effect damage in plant tissues is known from field observations and from cell biology experiments. In nature wind-chill may bring on a risk of frost even if the temperature is slightly above freezing such as 33° to 35° F.

Physiographically our land mass, bordered by the cold pre-Cambrian Shield in the east and the Rockies in the west, rises sharply westward from the Manitoba escarpment. It is influenced by a cold Continental air mass pressure system from the Arctic and by a warm

air mass from the Pacific. The two systems bring about rapid diurnal freeze-thaws so common during the winter months along the eastern slopes of the Rockies with greatest turbulence and gusty winds. Risk of frost is also increased by radiation diurnal cooling in broad valleys throughout the region. Disked surfaces tend to be cold and raised surfaces warm; but on long slopes night frost settles at the bottom and top of the slopes, and the warm layer is sandwiched in between. Risk of frost injuries increases from east to west and the eastern slopes of the Rockies have the greatest instability of temperature.

In reforestation, frost risk areas should be designated for wild-life use rather than timber because of stand openings and successions of herbaceous ground cover suitable for grazing. Such designations may be permanent, or temporary if a complete canopy cover is established. But trees with deformed crowns make a useful habitat for larger nesting birds rather than timber for fiber use.

Low temperature damage may have some impact on redirection of disease appraisal, research on regeneration by natural or artificial means, and on some of the cultural practices such as hardening-off of seedlings, prunning, thinning and selection of adaptable species.

9. Study Objectives:

a. To assess variability of hardiness of poplar to frost canker and dieback for clones under field conditions.

b. To provide advisory services to outside agencies on establishment and maintenance of planted poplars.

c. To compile manuscript on role of winter injury and process of dieback and target canker formation.

d. To study similar dieback and canker condition in other hardwoods and in conifers affected by low temperature damage under natural and artificial conditions.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: 1973 Revised: 1975
c. Estimated total Prof. man-years required: 3
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 1.0

11. Progress to Date:

In 1972, new information on frost canker was obtained from morphological data and climatological low temperature research. Tissue deformities in

burl, canker and pitch-pocket in pole sized and mature trees of 22 native species and 25 horticultural varieties were examined histologically. Regional climatological data have indicated that low temperature may have a direct killing effect on vital tissues as well as indirect slowing down or abnormal stimulation of new tissues around the killed area. Experimental low temperature damage under controlled and natural conditions has made it possible to induce stages of frost canker development and study its' morphological features during active stages of growth. Sclereid-like cells and short branching rays, tracheids and vessels of a few hosts were reported in a preliminary note. The sclereid-like cells occurred in the wood and bark of pine that normally does not produce sclereids and in the wood and bark of poplar that produces sclereids in the latter.

In 1973, I have verified the external and internal symptoms recognized in the field by experiments and explained the process of perennial frost canker. Investigations of natural and artificial induced frost injury in conifers and hardwoods has established that burls overgrowing the injured area, such as frost canker, completely or partially, have rhe same pathological pattern of development and maturation in all tree species investigated. Besides outright killing of living cells, frost injury causes cytological malfunctions of still-living adjacent cells during division of ray cells and cambium initials and during development of their derivatives. Differences found between the frost burl and canker are in the rate of production of burl tissues which form and converge rapidly in the former and slowly , if at all, in the latter. These tissues are unique pathologically in the presence of hyper- and hypoplasia, branching extreme diversity in cell structure, and anastomosis of tracheids and vessels to form multicellular structures new to science. Filamentous and muroid cellular ray patterns and physiologic ageing have also been demonstrated. There is also some evidence that particular species, such as spruce, produce burl tissues with greater ease than pine and may be better suited to recover from frost injuries in designated risk areas. This is accomplished by re-establishment of normal cambium. The pine is less tolerant to frost injury. Frost injuries affect all parts of the plant such as roots, stems, branches, shoots, buds, leaves or needles, fruits such as cones and seeds. Deformities occur in all.

12. Goals for 1973-74:

1. Prepare manuscripts on reaction wood occurring in frost injured conifers and hardwoods with emphasis on deformed tracheids, vessels and ray parenchyma, on frost burl, canker and dieback in conifers and hardwoods and aspects of cellular polymorphism (NOR-Y-11); and on air and soil temperature anomalies related to low temperature damage.

2. To obtain pathogomic data on reconstruction of cambium, phloem and xylem of field treated trees in clearcut areas held by

North Western Pulp and Power Ltd. and after treatments in the spring and fall of 1973 to effect alternate freeze-killing and rejuvenation and canker development.

3. To determine duration and time of season when occlusion wood is formed.

13. Accomplishments in 1973-74:

Goal No. 1 has not been completed because it was decided later to supersede the manuscripts for NOR-Y-11 with two manuscripts on experimental low temperature damage in trees maintained in the greenhouse. Goals 2 and 3 have to be continued into the summer of 1974 for completion.

Work is continuing towards satisfying Goal 1. A start has been made on one publication dealing with branchiate tracheids and one on sclereid-like cells of ray origin. Manuscripts titled "Frost Injury in Poplar" and "Structure of Burl Tissues in Frost Canker of Poplar" will be completed in current year. Two manuscripts, "Low Temperature Induced Cankers and Burls in Test Conifers and Hardwood" and "Cell and Tissue Deformities in Burl and Canker Induced Experimentally by Low Temperature" have been previewed outside the region.

Hyper- and hypoplasia is now under investigation using newly developed technique of isolating aberrant and diverse groupings and multinucleation in developing ray and conductive cells. This study should provide some of the basic knowledge required to understand the pathology of frost injury not available in previously published texts.

14. Goals for 1974-75:

1. To obtain pathognomic data on reconstruction of cambium, phloem and xylem of field treated trees in clearcut areas held by North Western Pulp and Power Ltd. and after treatments in the spring and fall of 1973.

2. To determine duration and time of season when occlusion wood is formed. To be continued.

3. To complete construction of an electronic cell and to determine the rate of loss and thermal diffusion from tissues adjacent to the target freezing area in the stem.

4. To evaluate multinucleation and cellular aberration during the production and development of burl hyper- and hypoplasic tissues.

5. To complete the following manuscripts for journal publication:

Zalasky, H. Low temperature induced cankers and burls in test conifers and hardwoods. Can. J. Botany.

Zalasky, H. Cell and tissue deformities in burl and canker induced experimentally by low temperature. Can. J. Botany.

Zalasky, H. Septoria canker and leaf spot in test seedlings of native species of poplar. Can. J. Botany.

Zalasky, H. Frost damage in poplar. Forestry Chron.

Zalasky, H. Structure of burl tissues in frost canker of poplar. Can. J. Botany.

Zalasky, H. Hyperplastic and hypoplastic tissues evaluated by aberration and diversity in nucleation and cell groupings. Can. J. Botany.

Zalasky, H. Structural malformation in woody tissues of *Malus* following experimental frost injury. Plant Sci.

Zalasky, H. Frost injury in Caragana. Plant Sci.

15. Publications:

1973-74

Zalasky, H. 1973. Brachiate tracheids in deformed wood of *Abies*. Bi-Mon. Res. Notes 29, 23.

Zalasky, H. 1973. Isolation and characteristics of sclereid-like cells in sapwood of *Pinus Populus*. Information Report NOR-X-48. 14 pp. Northern Forest Research Centre, Edmonton, Alberta.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 069

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1974

1. Project: Reduction of damage from disease causing agencies.

2. Title: A bark disease of poplar.

3. New: Cont.: X 4. No.: NOR 069

5. Study Leader: H. Zalasky

6. Key Words: *Populus balsamifera, Rhytidiella moriformis, Phaeoseptoria, Caliciopsis, Amphisphoeria.*

7. Location of Work:

8. Problem:

All stages of rough-bark disease of *Populus balsamifera* was discovered in 1964-65 in Saskatchewan and Manitoba. Pure stands of the fungus in infected bark simplified isolation. A project was formalized after the first initial pathogenicity test was successful. Pathogenicity and life cycle studies proved to be promising enough to include the fungus in tests for resistant host as a next step in research and development initiated at Winnipeg prior to 1969. However, closure of the laboratory prompted abandonment of the progeny testing programme in poplar under project leader Dr. K. Roller.

9. Study Objectives:

a. To provide knowledge on pathogenicity, tree damage symptomatology, and cultural characteristics of *R. moriformis*.

b. To determine various aspects of the life history and host parasite relationship, nutritional and physiological requirements; to describe the fungus and its related species.

c. To provide advisory services to outside agencies on establishment and maintenance of planted poplars.

10. Resources:

a. Starting date: 1965
b. Estimated year of completion: 1969 Revised 1971
Revised 1974
c. Estimated total Prof. man-years required: Nil
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. Nil
Supp. Nil
Casual Nil

11. Progress to Date:

The fungus, *Rhytidiella moriformis* from a type locality and material was named and a description published. Portions of the type specimen were deposited in several major harbaria. The description includes all states, perithecia and two forms of pycnidia, and geographic and host distribution. Like *D. tumefaciens* a perennial fungus, the fungus colonizes outside the active phloem and stimulates thick corky bark in most parts of the stem except current year's growth. Microscopic examinations are expected to be completed before the end of the fiscal year 1973-74 for compilation of report.

12. Goals for 1973-74:

Complete histological investigation on pathogenicity and complete preparation of manuscript.

13. Accomplishments in 1973-74:

Nil

14. Goals for 1974-75:

No change in goal but expect to complete study during the latter part of 1973-74.

Zalasky, H. "Cell and tissue deformities in burl and canker induced experimentally by low temperature. Manuscript written (under review) for Can. Journal Botany".

15. Publications:

Up to 1973-74

Nil

1973-74

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 023

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Impact, biology and control of the spruce budworm in Alberta and Northwest Territories.

3. New: Cont.: X 4. No.: NOR 023

5. Study Leader: H. F. Cerezke

6. Key Words: *Choristoneura fumiferana, C. biennis, Picea glauca,* sample, defoliation, clearcutting, regeneration, pheromone.

7. Location of Work: Edmonton

8. Problem:

The recent large-scale outbreak of the spruce budworm in the Prairie provinces, Yukon and NWT reached a peak in 1967-68 and declined over large areas in 1969-70. Most infestations occurred in commercial mature-overmature white spruce stands along major river drainages and in several park and recreational areas. Defoliating damage during outbreak resulted in tree mortality, growth losses, dead tree tops, increased fire hazard and decreased aesthetic appearance, and caused concern to many agencies. In response to these, research efforts have been directed toward improving monitoring techniques, assessing hazard and examining control strategy.

9. Study Objectives:

a. Determine the biology and hazard of the budworm in northern spruce forests and suitable techniques for estimating its abundance.

b. Determine the formulation of control measures when required.

10. Resources:

a. Starting date: 1968
b. Estimated year of completion: 1974 Revised: 1975
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.3
Supp.
Casual
Total 0.3 O & M funds req'd:

11. Progress to Date:

Budworm infestations have been monitored in northern Alberta annually since 1968: outbreaks in the Athabasca Forest increased considerably in 1973 compared to previous year. Provincial forestry personnel have been kept informed.

Analyses of 360, 18-inch branch tips from non-infested spruce trees have been completed for describing important characteristics related to budworm sampling and damage assessment. Some comparative data were compiled on budworm-damaged branch tips, and also on radial increment patterns of sampled trees.

Field plots near High Level and Fort McMurray were used to collect general biological information on budworm life history, behaviour, survival and its development in relation to host phenology and temperature.

Several sampling techniques have been applied for various life stages, including branch sampling with pole pruners, tree felling, tree climbing and by moth trapping with virgin females and synthetic sex attractant. The sex attractant was field tested in a variety of spruce forest conditions near High Level, Fort McMurray and Kootenay National Park, and found to work well with western populations of *C. fumiferana* and *C. biennis*.

Preliminary studies were made to determine general defoliation patterns within tree crowns of different stand character in order to follow cumulative damage effects with outbreak development and with respect to cutting pattern; these data are incomplete. Field plots were established on clearcut sites to examine dispersal and subsequent damage of budworm larvae originating from adjacent mature timber.

Laboratory studies have examined rearing techniques and of early larval feeding damage to buds of greenhouse-grown spruce seedlings.

12. Goals for 1973-74:

1. Complete studies of budworm life history and development relating to degree-days.

2. Continue field tests with pheromone in sticky traps to monitor abundance and activity.

3. Prepare report summarizing foliage patterns in white spruce crowns.

13. Accomplishments in 1973-74:

1. Collections were made of overwintering, late larval, pupal and adult stages, but no further work done toward relating larval development and heat-units because of lack of data during first half of June. (No collections made in early June due to illness and lack of assistance.) 1973 collections have allowed completion of larval instar size measurements to be made.

2. Virgin female moths were reared and used to complete comparison tests with synthetic pheromone. Seven forest situations were monitored with pheromone traps west of High Level and showed similar catch results as in 1972. Field experiments near Fort McMurray established that 10 mg/trap is a convenient and effective concentration for population monitoring, and that it remains attractive for about 60 days in the field.

3. First draft report in preparation and expected by March, dealing with foliage patterns in white spruce crowns.

4. Aerial survey made of budworm infestation in Athabasca Forest (July, 1973), followed by ground examination of infested timber (February, 1974); both at request of AFS.

5. Two plot areas, each with 1,000 planted seedlings, established to examine larval dispersal and damage in clearcuts was re-examined in 1973 and showed low survival (about 5%) due to poor planting stock. However, adequate natural regeneration has compensated for this loss.

14. Goals for 1974-75:

No field studies are planned but time is required to complete the reporting of research results. Three reports are proposed to summarize most of the publishable material related to Objective (1). Approximate titles of proposed Information Reports are as follows:

1. Analysis of foliage patterns in white spruce crowns as a basis for sampling spruce budworm populations and its damage.

2. Sex attractant trap tests of *Choristoneura fumiferana* in Alberta and their potential as a survey tool in northern spruce forests.

3. Spruce budworm development in northern Alberta in relation to spruce phenology and heat-units.

15. Publications:

Up to 1973-74

Sanders, C. J., G. R. Daterman, R. F. Shepherd and H. F. Cerezke. Attractants for two western spruce budworms, *Choristoneura biennis* and *C. viridis*. pp. 6. Accepted by Can. Ent.

Cerezke, H. F. 1971. Spruce budworm. Forestry Report 1(4):7.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 024

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Biology and control of Warren's root collar weevil.

3. New: Cont.: X 4. No.: NOR 024

5. Study Leader: H. F. Cerezke

6. Key Words: *Hylobius warreni*, *Pinus contorta* var. *latifolia*, regeneration, growth reduction, stand treatments, B19, sampling.

7. Location of Work: Alberta foothills, Edmonton

8. Problem:

H. warreni is trans-Canadian in distribution, occurs in most native spruce and pine forests in the Prairie provinces and southern NWT, and is abundant on high productivity sites of lodgepole pine along the Alberta foothills and in moist sites of white spruce and jack pine in central Saskatchewan and western Manitoba. Healthy trees are attacked when a few years old and until mature. Girdling damage by larvae causes death of trees and growth losses, which may cumulate during life of tree. Damage has been most severe (up to 63% mortality) in plantation-type situations, indicating this insect to be a potential economic pest during at least the first 30 years after seeding and planting.

9. Study Objectives:

Broad objective is to obtain information to make concrete recommendations for weevil control. Specific objectives are:

a. To determine the subsequent population changes and damage patterns of the weevil in a young pine stand subjected to thinning.

b. Determine experimentally the relationship between amount of girdling and its effects on tree growth.

10. Resources:

a. Starting date: 1960
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.3
Supp.
Casual ___
Total 0.3 O & M funds req'd:

11. Progress to Date:

Considerable background knowledge on the biology of *H. warreni* and its damage in lodgepole pine stands in Alberta has been accumulated from 1961 to 1972. Information was obtained on the geographical distribution of *H. warreni*, its life cycle development in the Alberta foothills, on sampling and collecting techniques and identification of some mortality factors. Data were obtained on the behaviour patterns of adults in relation to mating, egg-laying, feeding, dispersion and daily and seasonal activity. Populations were studied in several different forest conditions and patterns of attack on the host were determined, history of attacks and relationships between weevil numbers and several forest parameters such as tree age and size, stand density and depth of duff material. Populations were followed over a five-year period in a pulp-cutting area to determine survival of the weevil in cut stumps and to evaluate clearcutting as a method of control. Studies were made of girdling effects on trees having 50% of the root-collar circumference girdled by larvae, and of changes in the resin duct system. A study, completed in 1972, examined growth losses on pine girdled various amounts around the root-collar circumference to simulate weevil feeding injury. Two fifth-acre plots, thinned in 1967, were re-examined for weevil populations and damage in 1969 and 1971. A thesis, several reports and publications summarize much of these data.

12. Goals for 1973-74:

Goals 1, 2 and 3 are proposed journal publications; first draft copies to be completed.

1. The spacial and temporal patterns of distribution of the weevil, *Hylobius warreni* Wood, in lodgepole pine stands in Alberta.

2. Behaviour patterns of *Hylobius warreni* Wood in relation to mating, egg-laying, feeding, dispersion and daily and seasonal activity.

3. Effects of partial girdling of the root-collar on growth impact of stem, leader and lateral roots of lodgepole pine, with special application to damage by the weevil, *Hylobius warreni*.

4. Re-examine two fifth-acre thinned plots and their control plots in a 30-year-old lodgepole pine stand and determine the effect of thinning on weevil abundance and feeding damage since time of initial treatment (1967). This will contribute toward satisfying objective 1.

13. Accomplishments in 1973-74:

1. and 2. No progress made on these two proposed journal publications due to lack of time and assistance.

3. First to final draft copies completed for this proposed journal publication and submitted to HQ.

4. The two fifth-acre thinned plots and their controls were re-examined in 1973. Larval feeding damage and weevil abundance were measured and the data have been analyzed for trends since 1967.

5. A survey of root weevil abundance and damage was made in five pine regeneration sites including one plantation, established on areas previously clearcut. Two sites had respectively 10% and 23% tree mortality from larval girdling and up to 25% additional mortality may be expected over the next few years. Tree damage was most prevalent on rich growing sites of low density stocking, suggesting that the weevil is not an important thinning agent in densely stocked stands.

6. Cerezke, H. F. and V. Hildahl. 1973. Insect and rodent damage associated with regeneration. Forestry Report 3(2):2-3.

14. Goals for 1974-75:

1. Undertake field studies to assist in locating pine regeneration plots and assisting pre- and post-treatment examinations of trees chemically treated for weevil control by Drouin and Kusch (NOR 132).

2. Re-tag thinned plots for upkeep of trees is necessary if thinned-plot study to be continued.

Prepare first drafts of 3 and 4 as follows:

3. "The spacial and temporal patterns of distribution of the weevil, *Hylobius warreni* Wood, in lodgepole pine stands in Alberta" Proposed Journal publication.

4. "Behaviour patterns of *Hylobius warreni* Wood in relation to mating, egg-laying, feeding, dispersion and daily and seasonal activity" Proposed Journal publication.

5. Work toward publishing: Cerezke, H. F. Effects of partial girdling on growth in lodgepole pine with application to damage by the weevil *Hylobius warreni* Wood. Submitted as journal paper to Can. J. For. Res.

6. Commence preparation of Information Rpt. or Pest Leaflet on *H. warreni* in Prairie Provinces aimed at Management Agencies (suggested 4 - 8 pp).

15. Publications:

Up to 1973-74:

Cerezke, H.F. 1967. A method for rearing the root weevil, *Hylobius warreni* (Coleoptera: Curculionidae). Can. Ent. 99:1087-1090.

Cerezke, H. F. 1969. The distribution and abundance of the root weevil, *Hylobius warreni* Wood in relation to lodgepole pine stand conditions in Alberta. Ph.D. thesis, University of British Columbia, xvii + pp. 221.

Cerezke, H. F. 1970. A method for estimating abundance of the weevil, *Hylobius warreni* Wood, and its damage in lodgepole pine stands. For Chron. 46:392-396.

Cerezke, H. F. 1970. Biology and control of Warren's collar weevil, *Hylobius warreni* Wood, in Alberta. Internal Report A-27. pp. 28.

Cerezke, H. F. 1970. Survey report of the weevil, *Hylobius warreni* Wood, in the foothills of Alberta. Internal Report A-38. pp. 40.

Cerezke, H. F. 1972. Effects of weevil feeding on resin duct density and radial increment in lodgepole pine. Can. J. For. Res. 2:11-15.

Cerezke, H. F. 1973. Some parasites and predators of *Hylobius warreni* in Alberta. Bi-monthly Res. Notes 29:24-25.

Cerezke, H. F. 1973. Survival of the weevil, *Hylobius warreni* Wood, in lodgepole pine stumps. Can. J. For Res. 3:367-372.

Cerezke, H. F. 1973. Bark thickness and bark resin cavities on young lodgepole pine in relation to *Hylobius warreni* Wood (Coleoptera:Curculionidae) Can. J. For. Res. 3:599-601.

Cerezke, H. R. and V. Hildahl. 1973. Insect and rodent damage associated with regeneration. Forestry Report 3(2):2-3.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 025

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Biology, impact and control of woodborers.

3. New: Cont.: X 4. No.: NOR 025

5. Study Leader: H. F. Cerezke

6. Key Words: Cerambycidae, *Monochamus*, *Tetropium*, white spruce, pine, sampling.

7. Location of Work: Entire Region and Edmonton.

8. Problem:

Requests are received annually from industry and provincial forestry personnel for information on hazard, expected damage, life history, identification and methods of control of woodborers attacking freshly-cut and fire-killed timber, and insect material found in finished wood products. Most of these requests are handled by telephone, letter or short personal visit. However, special surveys are required from time to time such as in examining fire-killed timber for hazard and salvage logging or examining log decks to establish effectiveness of chemical spray treatment.

9. Study Objectives:

a. Develop new or improve existing sampling systems for estimating numbers of woodborers in logs of different dimension, species and for fire-killed, blowdown and freshly-cut trees decked and undecked.

b. Investigate complaints of clients and make recommendations for control of woodborers where possible.

10. Resources:

a. Starting date: 1967 by A. Raske and T. Szabo
1970 by H. F. Cerezke
b. Estimated year of completion: continuous Revised: 1975
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.2
Supp.
Casual
Total 0.2 O & M funds req'd:

11. Progress to Date:

The following summarizes progress by Raske.

Ecological and biological studies of *Monochamus* spp. and *Tetropium* spp. in Alberta were made. Other cerambycid and buprestid species were studied to a limited extent from pine and spruce logs; identifications of these were made.

A larval rearing program of woodborer species was undertaken with Dr. Gardiner of Sault Ste. Marie to establish species identity in larval stages. Hybridization studies were conducted with crosses of *Monochamus oregonensis* and *M. scutellatus* to establish their taxonomic relationships. The identification of chromosome pairs was assisted by Dr. G. Lanier.

Pine and spruce logs have been sampled in various parts of Alberta to establish densities of woodborers in decked and undecked logs, and in relation to position on log and position within decks. From the pine log data a sequential sampling plan was developed, with input by L. Safranyik, for estimating the degree of *Monochamus* infestations. Infested logs were sawn and the lumber product graded to establish a relationship between *Monochamus* damage intensity and percentage value-loss.

The effect of time-of-year of log felling was studied in relation to attack density of *Monochamus*. The study suggested 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 summer were most attractive.

Preliminary tests of the chemical PDB (Para-dichloro benzene) were made on small experimental log decks. Results of these tests for control of woodborer larvae were promising.

Several reports and publications summarize most of these data; see list under item #15.

Studies by Cerezke examined white spruce logs for development, survival, attack density, damage characteristics and adult size of *Monochamus scutellatus*. These studies are completed and the data have been analyzed.

Information on woodborer damage and hazard was provided to several agencies, including an assessment of woodborer hazard in fire-killed timber (see file report NOR-Y-25, 1972).

12. Goals for 1973-74:

1. No major field studies are planned but limited time will be made available to investigate requests of clients (objective 2).

2. Data analysis on 1971 log-samples will be completed and a report prepared (objective 1).

3. Contact other regions for "extension handout" information on woodborer damage hazard and control and modify these or prepare a similar handout for clients in this region.

13. Accomplishments in 1973-74:

1. Three requests of clients were received re woodborer hazard and control. One involved examination of log decks in the Swan Hills following spray treatment for woodborer control (file report prepared for concerned parties).

2. Some time spent on completing analyses of log-sample data, but no time was available for initiating a report.

3. All regions were contacted for "extension handout" information on woodborer damage hazard and control; two replies were received and an illustrated first draft of a pest leaflet was prepared. In addition, a similar pest leaflet proposal was received from Eastern Forest Products Laboratory for review and comment.

14. Goals for 1974-75:

1. Complete pest leaflet of: "Biology, damage and control of the white-spotted sawyer beetle in logs".

2. Prepare proposed Journal paper as follows: "Population and damage relationships of *Monochamus scutellatus* in tree-length white spruce logs in northern Alberta". Suggested for Can. Ent. or Can. J. For. Res.

15. Publications:

Safranyik, L. and A. G. Raske. 1970. Sequential sampling plan for larvae of *Monochamus* in lodgepole pine logs. Journ. Econ. Ent. 63:1903-1906.

Lanier, G. N. and A. G. Raske. 1970. Multiple sex chromosomes and configuration polymorphism in the *Monochamus scutellatusoregonensis* complex (Coleoptera:Cerambycidae) Can. J. Genet. Cytol. 12:947-951.

Dahl, B. M. 1971. Mortality of *Monochamus* larvae in slash fires. Bi-Monthly Research Notes, 27:12.

Raske, A. G. 1973. *Tetropium parvulum* elevated to species rank and contrasted to *T. cinnamopterum* in morphology and host preference (Coleoptera:Cerambycidae). Can. Entomol. 105:745-755.

Raske, A. G. 1973. Notes on the biology of *Tetropium parvulum* (Coleoptera:Cerambycidae) in Alberta. Can. Entomol. 105:757-760.

Raske, A. G. 1973. Taxonomic relationship between *Monochamus scutellatus* and *M. oregonensis* (Coleoptera:Cerambycidae). Can. Entomol. 105:795-806.

Raske, A. G. 1973. Relationship between felling date and larval density of *Monochamus scutellatus*. Bi-Monthly Res. Notes 29:23-24.

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

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. pp. 12.

Raske, A. G. 1972. Biology and control of *Monochamus* and *Tetropium*, the economic woodborers of Alberta (Coleoptera:Cerambycidae) Internal Report NOR-9. pp. 48.

Cerezke, H. F. and F. J. Emond. 1972. As assessment of woodborer hazard in merchantable timber after the 1972 "Martin Hills Burn", Slave Lake Forest, Alberta. File report NOR-Y-25. pp. 6.

Cerezke, H. F. 1973. Results of an examination of cut pine and spruce logs for woodborer damage in the Swan Hills. pp. 3.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 061

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Larch sawfly biological control.

3. New: Cont.: X 4. No.: NOR 061

5. Study Leader: J. A. Muldrew

6. Key Words: *Pristiphora erichsonii, Olesicampe benefactor, Mesoleius tenthredinis, Mesochorus dimidiatus,* parasites, encapsulation, hyperparasites, *Larix,* Boreal Region "B".

7. Location of Work: Throughout Northern Forest Region.

8. Problem:

This study is an attempt to control the larch sawfly by the introduction of exotic biotic natural enemies. 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. The benefits from success would be reduced mortality of tamarack and appreciable increases in the total incremental growth of tamarack and western larch. The increased vigor of tamarack would allow it to better fulfill its role in the ecology of the forest as a pioneer species invading areas not previously occupied by trees.

The project is a success to date in that host populations have been reduced to a low level in the areas where the parasite has been present for five or more years.

Because of the success in Manitoba, releases of *O. benefactor* have been made in New Brunswick, Nova Scotia, Prince Edward Island, Maine and Minnesota and consideration is being given to making releases in British Columbia and in the larch plantations of southern Ontario.

9. Study Objectives:

a. To achieve biological control of the larch sawfly.

b. To contibute to the population dynamics study of the larch sawfly by determining the factors affecting parasite effectiveness, abundance and impact.

c. To monitor the spread of *Olesicampe benefactor* from release points in Manitoba, Saskatchewan, Alberta and the Northwest Territories.

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

10. Resources:

a. Starting date: 1950
b. Estimated year of completion: 1975 Revised:
c. Estimated total Prof. man-years required: 2
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.8 (J.A. Muldrew)
Supp. 0.5 (R.M. Smith)
Casual ___
Total 1.3 O & M funds req'd:

11. Progress to Date:

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 cooperation with the Entomology Research Institute, Ottawa, revealed

that the hyperparasite had a holarctic distribution before *O. benefactor* was released in America.

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 were 7.2 and 8.3 miles. In 1969 it was recovered about 45 miles from the release point and in 1970 had reached the Rennie life table plot, a distance of 65 miles. In 1971 a spectacular population explosion accompanied by long range dispersal was detected. The known distribution covered an egg-shaped area extending from Lake Winnipeg to Fort Frances and Ignace in Ontario, a maximum distance of about 225 miles from the point of release. The rates of parasitism averaged 90% for nearly half of the total area. In 1972 the parasite spread eastward and southward about 50 miles from the 1971 boundary. Parasitism by *O. benefactor* at the 1971 boundary increased from close to 0 in 1971 to about 50% in 1972.

At the Pine Falls release plot where larch sawfly density had been decreasing progressively from over 500,000 cocoons per acre in 1964, a low of 871 was reached in 1972. From 1969 to 1972 the rate of attack by *O. benefactor* dropped from 94% to 50% at Pine Falls, probably due to the increasing scarcity of larch sawflies and the effect of *Mesochorus dimidiatus* which reached a high attack rate against *O. benefactor*.

Releases of *O. benefactor* were made in 1972 by placing out "small" larch sawfly cocoons and the estimates of parasites released were: Jarvie, Alberta - 1,139; Primrose Lake, Alberta - 1,283; Grovedale, Alberta - 469 and Hay River, Northwest Territories - 856.

Parasitism by the Bavarian strain of *M. tenthredinis* in the Rennie plot decreased from a high level in 1970 to a low level in 1972 as *O. benefactor* moved in and increased to a high rate of attack, indicating that *M. tenthredinis* discriminates against hosts already attacked by *O. benefactor* as was found by workers in Europe.

12. Goals for 1973-74:

1. Emphasis in 1973-74 will be on completing publications, the tentative titles of which are:

   a. History and etiology of two major continental outbreaks of the larch sawfly in North America.

   b. Dispersal of the introduced larch sawfly parasite, *Olesicampe benefactor* from the Pine Falls release point, 1966 to 1972.

   c. Characteristics of *Bessa harveyi* (Diptera:Tachinidae) suggesting the historic introduction of the larch sawfly to North America (by W. J. Turnock and J. A. Muldrew).

d. A literature review of parasites of the larch sawfly, worldwide.

e. Releases of *Olesicampe benefactor* in Alberta and the Northwest Territories in 1972 (Information Report).

2. Release of *O. benefactor* adults reared in Edmonton near Ellscott, Alberta, where defoliation of large tamaracks was medium to heavy in 1972.

3. Monitoring the 1972 release points in Alberta and the N.W.T. for establishment of *O. benefactor* by collecting larvae both for rearing to the cocoon stage and for preservation for parasitism estimation by the clearing technique.

4. To monitor the dispersal of *O. benefactor* and *M. dimidiatus* in western Manitoba and Saskatchewan. (Responsibility for monitoring dispersal through Ontario will be given to the GLFRC.)

13. Accomplishments in 1973-74:

1. a. A preliminary set of maps illustrating the 1940 to 1970 outbreak has been completed. The compilation and collation of extensive data pertaining to this outbreak and the one that began in 1880 is almost complete. When complete, the final maps will be drawn and the paper written. Work on this paper was postponed in 1973-74 awaiting the completion of publication 1 (b) which was given priority so that it could be finished while the subject was topical.

b. Completion of this paper awaits the examination of the remaining cleaned larvae collected during the 1972 survey in Manitoba and Ontario. Approximately 3,000 second-and third-instar larvae have been examined but 4,000 remain to be checked. It is planned to examine only half of these following which the publication will be completed.

c. The publication "Characteristics of *Bessa harveyi* (Diptera: Tachinidae) suggesting the historic introduction of the larch sawfly to North America" was completed and published.

d. A summary of available literature and data has been made. Completion of the paper awaits some identification of specimens and the checking of scientific names and synonymy by Ottawa specialists.

e. The data has been compiled and analyzed but writing the report was postponed awaiting completion of publication 1 (b).

2. Release of *O. benefactor* totalling 118 males and 122 females were made in a light population of larch sawfly near Ellscott, Alberta on July 10 and July 18, 1972.

3. Monitoring the 1972 releases made in Alberta and the N.W.T. was hampered by scarcity of host larvae. A search was made at all four locations by FIDS Rangers but sufficient larvae for analysis were obtained only at the Jarvie release point. In this collection, however, measurement of the head capsules of 38 fifth instar larvae indicated a 34% parasitism by *O. benefactor*.

4. A marked decrease in larch sawfly populations occurred throughout eastern Manitoba and western Ontario in both 1972 and 1973 and workers from the GLFRC were unable to collect sufficient larvae to determine dispersal in Ontario. Although the host was more abundant as distance from the Pine Falls release point increased, the marked decline in areas that *O. benefactor* had only recently invaded indicates that factors other than the parasite are mainly responsible for the decline.

   Heavy sawfly infestations occurred near The Pas, Manitoba, both 9 miles north and 40 miles south of the release point but *O. benefactor* was not present in these although it was found to have attacked over 80% of the hosts in light infestations up to two miles from the release point.

   The trends in sawfly abundance and percentage parasitism by *O. benefactor* since 1969 in the three study plots sampled in 1973 were as follows:

	Pine Falls		Rennie		Agassiz	
Year	Cocoons per acre	Parasitism by *O. benefactor*	Cocoons per acre	Parasitism by *O. benefactor*	Cocoons per acre	Parasitism by *O. benefactor*
1969	132,200	94%	407,500	0%	264,400	0%
1970	35,300	91%	403,800	2%	206,300	2%
1971	4,400	85%	34,200	85%	432,300	69%
1972	870	50%	100,200	72%	2,400	91%
1973	0	-	87,700	95%	9,800	93%

14. Goals for 1974-75:

1. To find areas where collecting sawfly larvae parasitized by *O. benefactor* is practicable and to collect and rear to the cocoon stage up to 25,000 of such parasitized hosts to provide parasite material for release in Nova Scotia and British Columbia in 1975. This program contingent upon outside funding.

2. To complete publications, the tentative titles of which are:

   a. Dispersal of the introduced larch sawfly parasite, *Olesicampe benefactor* from the Pine Falls release point, 1966 to 1972.

   b. History and etiology of two major continental outbreaks of the larch sawfly in North America.

   c. Releases of *Olesicampe benefactor* in Alberta and the Northwest Territories in 1972 (Information Report).

3. Monitoring the 1972 release points in Alberta and the N.W.T. and the 1973 release near Ellscott for establishment of *O. benefactor* by collecting larvae both for rearing to the cocoon stage and for preservation for parasitism estimation by the clearing technique.

4. To monitor the dispersal of *O. benefactor* and *M. dimidiatus* in western Manitoba and Saskatchewan.

15. Publications:

Up to 1973-74

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Muldrew, J. A. 1953. The natural immunity of the larch sawfly (*Pristiphora erichsonii* (Htg.)) to the introduced parasite (*Mesoleius tenthredinis* Morley), in Manitoba and Saskatchewan. Can. J. Zool. 31:313-332.

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Muldrew, J. A. 1959. Studies on the distribution and inheritance of the resistance of the larch sawfly to *Mesoeius tenthredinis* Morley. Interim Rept., For. Biol. Lab., Winnipeg. pp. 52.

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16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 098

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Natural control of the larch sawfly.

3. New: Cont.: X 4. No.: NOR 098

5. Study Leader: W.G.H. Ives and J. A. Muldrew

6. Key Words: *Pristiphora erichsonii*, *Larix*, population dynamics, ecosystem modelling, biological control.

7. Location of Work: Manitoba and Edmonton.

8. Problem:

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 programmes utilizing larch for fibre production or aesthetic purposes cannot be encouraged.

The large body of data amassed since the study of larch sawfly population dynamics was started in 1956 has never been thoroughly analyzed. This study was established to undertake these analyses.

9. Study Objectives:

a. To elucidate the population dynamics of the larch sawfly by exploring the ecological relationships between the insect and its environment.

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

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

10. Resources:

a. Starting date: 1966
b. Estimated year of completion: Indefinite Revised: 1976
c. Estimated total Prof. man-years required: 1.0
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years

Prof.	0.2	(W.G.H. Ives)
	0.2	(J.A. Muldrew)
Supp.	0.5	(R.M. Smith)
Casual		
Total	0.9	0 & M funds req'd:

11. Progress to Date:

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.

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 or specialized sampling procedures. The first category has been dictated by cuts in student support, the latter by loss of key personnel.

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. Summaries of mortality and survival based on samples of feeding larvae, falling larvae and larvae in cocoons have been prepared. Data on adult populations have been coded and have been sent to Biometrics Research Services for key punching.

12. Goals for 1973-74:

1. To complete preliminary investigations on the relative importance of various mortality factors affecting the immature stages of the larch sawfly.

2. To initiate 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. To complete preliminary evaluations of the role of recently introduced parasites in population regulation.

4. To obtain cocoon population and mortality estimates for three study plots in Manitoba (Pine Falls, Rennie and Seddon's Corner).

13. Accomplishments in 1973-74:

1. Data were edited, then subjected to a Varley-Gradwed key-factor analysis to determine which stages were related to total generation mortality. The key factor (or factors) apparently operated in the cocoon plus adult period (the two were combined), since the K values for this period showed a close relationship to the total K.

2. A breakdown of mortality during the cocoon plus adult period showed that two factors had a large amount of variation. These factors were small mammal predation and the effects of adverse moisture during larval drop and late summer after the cocoons were spun in the moss or duff. When these two factors, which seemed to be complementary, were added together they appeared to be the key factor.

3. Although recently introduced parasites, particularly *Olesicampe benefactor* Hirz, have attacked a large proportion of the larch sawfly larva (often over 90%) they have apparently not become a key factor. In fact, it has not been possible, so far, to demonstrate conclusively that they have been responsible for the observed declines in sawfly populations, since the declines have occurred more or less simultaneously in newly invaded areas and in areas where *O. benefactor* parasitism has been high for 7 or 8 years.

4. Cocoon population and mortality estimates are being obtained from cocoons collected from the Pine Falls, Rennie and Seddon's Corner plots. No cocoons were recovered from the Pine Falls plot, hence no mortality estimates will be possible.

5. Additionally, we cut a number of trees in these three plots this winter, and were able to obtain reasonably satisfactory estimates of the egg populations for 1972 and 1973, thus adding to the amount of data available for analysis.

14. Goals for 1974-75:

1. Continue analyses of existing data on larch sawfly populations.

2. If these analyses proceed favorably prepare a paper summarizing the results. A tentative title is "The dynamics of larch sawfly populations (Hymenoptera:Tenthredinidae)".

15. Publications:

Up to 1973-74

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Ives, W.G.H. 1962. Population and mortality assessment during the egg and larval stages of the larch sawfly, *Pristiphora erichsonii* (Htg.) Can. Ent. 94:256-268.

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1973-74

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16. Signatures:

_____	_____
Investigator	Program Manager
_____	_____
Investigator	Director G. T. Silver

NOR 132

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Controls for pests of shade, shelterbelts and ornamental trees and shrubs.

3. New: Cont.: X 4. No.: NOR 132

5. Study Leader: J. Drouin

6. Key Words: Efficacy, spraying, toxicology, pesticides, registrations, residuals, formulations.

7. Location of Work: Prairie Region.

8. Problem:

Insects and disease cause injury and/or mortality to ornamentals, shrubs and shade tree plantings. Economically these high cost plantings have amenity values greatly surpassing their forest counterparts resulting in more frequent requests to the Canadian Forestry Service concerning their condition.

Resource managers in parks and recreation areas and citizens in both urban and farm locations expect the Canadian Forestry Service to provide information on the occurrence of pests, their damage potential and more importantly on effective, low cost, low hazard control measures that are non-damaging to the environment. An integrated approach by supplementing natural means with chemical or biological controls is not only warranted but essential.

This study serves as a vehicle for the expansion of work on pest problems under a single coordinating project. Studies anticipated to extend longer than three (3) years will not be initiated.

Where controls are not feasible, or economically or biologically justified, such will be reported and included in Canadian Forestry Service control recommendations to the chemical firms.

Many chemicals (including microbials) are known to be effective and biologically safe but are registered for a very limited number of

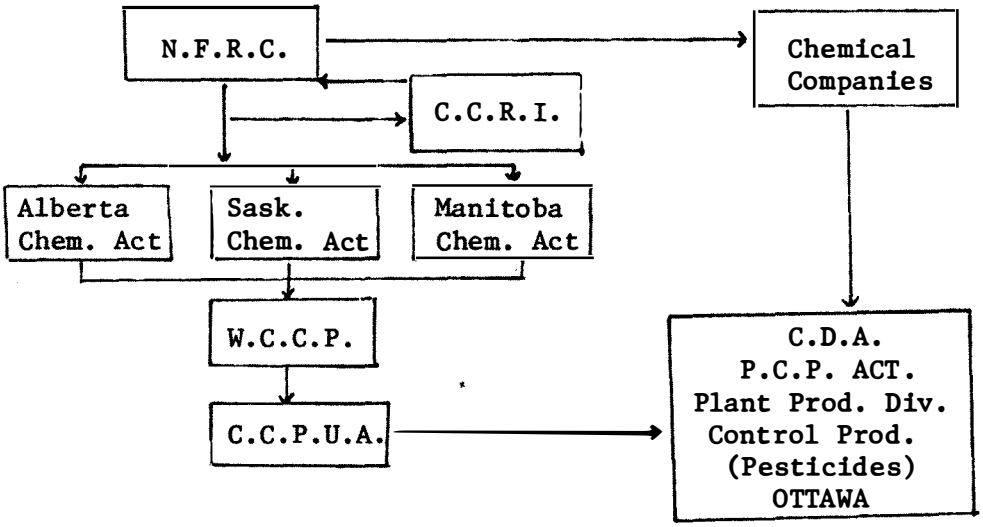
pests. In many instances there is a great need to obtain additional field data before these chemicals can be recommended for use against other pests. The most important part of the study will involve gathering the necessary technical data to support Canadian registration of the successful candidate materials.

A shade and shelterbelt pest priority outline has been established and is subject to annual review to meet current demands. The target pests have been selected from those recommended by the Canadian Forestry Service field staff, the Western Committee on Crop Pesticides and as compiled by the Chemical Control Research Institute.

The programme initiated in 1972 was primarily spray applications with a mist blower and numerous soil drenches and bark paint evaluations. Field trials using these methods will continue in 1973, particularly in the soil drench and bark paint evaluation techniques using systemics (tests have proven very successful) as an effective, low hazard, (drift) low cost, (minimal equipment) control.

During 1973 field trials will also be expanded to the use of a newly designed, specialized high pressure, hydraulic ground sprayer unit with 4 interconnected 45 gallon stainless steel tanks enabling the operator to conduct multiple efficacy trials concurrently at one location.

A schematic of other organizations in relation to chemical controls of insects and diseases.



9. Study Objectives:

1. To develop control methods for pest or disease problems using chemical, microbial and/or integrated control methods.

2. Efficacy trials for various dosages and formulations to determine percent mortality of target species and phytotoxicity.

3. Provide data to aid registration recommendations for selected chemical products.

10. Resources:

a. Starting date: 1972
b. Estimated year of completion: 1974 Revised: 1978
c. Estimated total Prof. man-years required: 0
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof.
Supp. 2.0
Casual ___
Total 2.0 O & M funds req'd.

11. Progress to Date:

Implemented a working unit, established contacts at the Federal, Provincial levels, municipal agencies and private industries involved in the use, manufacture and distribution of pesticides, and related products. Determined and selected safety clothing, equipment, ground spray instruments, techniques and methods. Established a pest priority list of 13 insect species requiring control recommendations. Conducted 59 efficacy trials on 11 insect species of which 43 were mist blower applications, 7 were bark paints and 9 were soil drenches. Analyzed the data, summarized the results and submitted performance reports to 9 chemical firms, report of trials and conclusions to the Western Committee on Crop Pesticides and prepared a file report on the trials and results.

12. Goals for 1973-74:

1. Continue efficacy trials on 15 major pests of shelterbelt and shade trees listed below in order of importance:

1. Spruce budworm
2. Yellow-headed spruce sawfly
3. Forest tent caterpillar
4. Cankerworm (spring and fall)
5. Jack pine budworm
6. Boxelder twig borer
7. Spruce gall aphid
8. Elm bark beetle
9. Large aspen tortrix
10. Poplar borers
11. Pine bark beetles
12. Poplar bud gall mite
13. Manitoba maple aphid
14. Spruce spider mite
15. Poplar leaf miners.

2. Expand trials to include the use of a newly developed hydraulic sprayer for more extensive coverage involving mature trees and to continue soil drench and bark paint-on trials emphasizing systemic chemicals.

3. Expand operations to biological control with a microbial type insecticide (Thuricide) high potency concentrate for trials against the forest tent caterpillar and also the use of fungicides in order to inactivate rust organisms on conifers.

4. Publication of an Information Report on the various tests and activities conducted in 1973 and the submission of confidential preliminary reports to participating chemical firms.

13. Accomplishments in 1973-74:

1. In 1973-74 the chemical control section carried out efficacy trials on 20 insect species with 30 different insecticides and 2 specialized mixtures for the new Ultra Low volume sprayers on 5 insect species to obtain information on proper timing, type of equipment best suited and effects of the chemicals used on target and on birds, small mammals, amphibians or other beneficial insects (bees, parasites, etc.).

Forest tent caterpillar, *Malacosoma disstria* Hbn. MATERIALS: Furadan 4.8 EC (carbofuran), PP 484 25% EC, Lannate (methomyl) 90% WP, Lorsban 25W, Zectran 2E, Sevin 50W and Sevimol 4 (carbaryl), Meta-Systox-R 25% EC, Nexion 25 WP (bromophos), Imidan 1E and 50W, Thiodan 4E (endosulfan), Fundal SP 97%, Baygon 1.5 EC, Basudin 50 EC (diazinon), Galecron 50 EC, UNI-K-840 48%, Cygon 4E (dimethoate).

Yellow-headed spruce sawfly, *Pikonema alaskensis* Roh. MATERIALS: Lannate (methomyl) 90% WP, Sevimol 4 (carbaryl), Lorsban 25W, Furadan 4.8 EC (carbofuran), Malathion (ULVA Turbair), PP 484 25% EC, Furadan 10G (carbofuran), Temik 10G (aldicarb), Vapona-Methoxychlor (ULVA), Thimet 10G (phorate), K 840 48% EC.

Poplar root collar borer, *Saperda calcarata* Say MATERIALS: Thimet 10G (phorate), Temik 10G (albicarb), Meta-Systox-R 25% EC, Furadan 10G (carbofuran) 2, Cygon 4E (dimethoate), PP 484 25% EC, Baygon 1.4 oil, K 840 48% EC, Di-Syston 15G (disulfoton), Galecron 50 EC.

Boxelder twig borer, *Proteoteras willingana* Kft. MATERIALS: Cygon 4E (dimethoate), Temik 10G (aldicarb), Furadan 4.8 EC (carbofuran), Basudin 50 EC (diazinon), Zectran 2E, Furadan 10G (carbofuran), Meta-Systox-R 25% EC, Thimet 10G (phorate).

Blotch leaf miner, *Lithocolletis* sp. MATERIALS: Imidan 1E, Basudin 50 EC (diazinon), Kelthane EC (dicofol) 18%, Malathion 50 EC (Cythion), Baygon 1.5 EC, Supracide 40 EC, Di-Syston 15G (disulfoton), PP 484 25% EC.

Boxelder aphid, *Periphyllus negundinis* Thos. MATERIALS: Furadan 4.8 EC (carbofuran) 2, Lannate L 25% (methomyl), Basudin 50 EC (diazinon), Pirimor 50W, Malathion (ULVA Turbair), Carzol SP 92% (formetanate).

Woolly elm aphid,*Eriosoma americanum* Riley and the elm gall mite, *Aceria ulmicola* (Nalepa) MATERIALS: PP 484 25% EC, Fundal SP 97%, K 840 48% EC, Supracide 40 EC, Omite 30W.

Spruce needle miner, *Taniva albolineana* Kft. MATERIALS: Furadan 4.8 EC (carbofuran).

Ugly nest caterpillar, *Archips cerasivorana* Fitch., cherry midge, *Contarinia virginianiae* Felt. and gall mites, Eriophyes sp. MATERIALS: Cygon 4E (dimethoate), Supracide 40 EC, Meta-Systox-R 25% EC, Kelthane EC 18% (dicofol).

Alder lace bug, *Corythucha pallipes* Parsh. MATERIALS: Supracide 40 EC, Malathion (ULVA Turbair), Kelthane EC (dicofol) 18%, Imidan 1E.

Pear slug, *Caliroa cerasi* Linn. MATERIALS: Malathion (ULVA Turbair), Vapona-Methoxychlor (ULVA Turbair).

A sawfly, *Trichiocampus irregularis* (Dyar.) MATERIALS: Vapona-Methoxychlor (ULVA Turbair).

Larch sawfly,*Pristiphora erichsonii* Htg., currant worm,*Nematus ribesii* Scop., pine needle scale, *Phenacaspis pinifoliae* Fitch and lilac leaf miner, *Gracillaria syringella* Fabr. MATERIALS: Furadan 10G (carbofuran).

2. Conducted 99 field trials of which 48 were mist blower applications, 28 soil drenches, 13 hydraulic sprays, 3 bark paints and 7 ultra low volume applications.

3. Analyzed the data and submitted performance reports to 14 chemical firms, submitted a summary of 94 trials (13 reports) to the Pesticide Research Report for publication by the Canadian Committee on Crop Pesticide Research in Agriculture (CCPUA).

4. Information reports on 1973 product performance to manufacturers of pumps and sprayers (ULVA).

5. Report of trials and conclusions to the Western Committee on Crop Pesticides (WCCP), report on insecticide field development to the joint conference of the Canadian Entomological Society/Alberta Entomological Society at Banff and input into the technical sessions on Biocides by the Alberta Environmental Conservation Board.

6. Prepared an Information Report outlining work undertaken and results obtained and a special report on a Furadan (carbofuran) package (16 trials) to CCRI, Ottawa.

7. Collaborated with CCRI, Ottawa and Province of Manitoba, Wildlife and Forestry Services on large scale Bt (microbial) spray programme on spruce budworm (14 days) from May 29 to June 11. Goals were: the control of spruce budworm through aerial sprays w/Fenitrothion @ 0.6 oz ai/ac and high-volume aerial sprays with Thuricide R and Dipel R @ 0.25 lb/ac and 0.5 lb/ac respectively and Sevin 4 oil ; evaluate efficacy of both microbials as sprays by mist blower application for control of spruce budworm; evaluation of air-emulsion spray adjustment and foam-emission hardware; *bird and small mammal censusing (*song and game).

8. No biological controls were possible in Alberta as a result of loss of timing while away on Spruce Woods Forest spray operation (Goal #3).

14. Goals for 1974-75:

Continue efficacy trials on top half dozen pest problems in the region with a more intensive evaluation on target and non-target species and of fewer pesticides:

1. Bt (*Bacillus thuriengensis*) microbial dosage studies on forest tent caterpillars in Alberta also large scale trials with Gardona and Sevimol and effects of these treatments on the target species as well as on birds and small mammals.

2. Continue poplar root collar studies with Furadan and Temik at reduced formulations and at up to 50 lbs/acre.

3. Continue soil drench trials on yellow-headed spruce sawfly with Temik and spray trials with carbaryl (Sevin), Cygon 4E and Malathion to obtain additional data for supporting product registration.

4. Soil drench trials on pear slug, birch leaf miner and Hylobius weevil with Cygon 4E, Furadan, Temik and on larch shelterbelt at Sangudo for sawfly using similar products.

5. Fungicidal control of poplar leaf spots in shelterbelts with benomyl and thiophanate to augment product registration data in support of L. W. Carlson's nursery trials including the effects on birds/small mammals.

6. Continue trials on *Lithocolletis* sp. with reduced formulations of Baygon (propoxur).

7. Fungicidal controls of *Monilmia* sp. fungus on Saskatoon as at #5 and control of fruit maggot with systemics.

8. Preliminary trials on controls of carpenterworm attacks in poplar shelterbelts at Crowfoot with systemics and fumigants.

9. Evaluation of air-emulsion spray adjuvants and foam producing spray emission equipment on spraying systems gun.

15. Publications:

Up to 1973-74

Nil

1973-74

Drouin, J. A. and Kusch, D. S. 1974. Pesticide efficacy trials on shade and shelterbelt insects and Index of chemicals for Pesticide Research Report (CCPUA) pp. 26.

Drouin, J. A. and Kusch, D. S. 1974. Summary of Insecticide Field Trials on Shade and Shelterbelt Trees in Alberta, Canada Dept. of Environment, Can. For. Serv., Northern Forest Research Centre, Edmonton, Alberta. Information Report . pp. 32.

Drouin, J. A. and Kusch, D. S. 1974. Efficacy Trials with Furadan, 10G and 4.8 flow (carbofuran) in Shade and Shelterbelts in Alberta, 1973. Canada Dept. of Environment, Can. For. Serv., Northern Forest Research Centre, Edmonton, Alberta. (Summary report to CCRI) pp. 35.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 133

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects.

2. Title: Biological control of forest tent caterpillar.

3. New: Cont.: X 4. No.: NOR 133

5. Study Leader: J. A. Muldrew

6. Key Words: *Malacosoma disstria, Sarcophaga aldrichi, Pseudosarcophaga affinis*, parasites, nuclear-polyhedrosis virus, Boreal Region "B", trembling aspen *(Populus tremuloides)*.

7. Location of Work: Northern Forest Research Centre and Region.

8. Problem:

The forest tent caterpillar shows large population fluctuations with outbreaks of 3-6 years duration occurring at intervals of 6-16 years. Successive complete defoliation for three or more years can cause death of aspen but the more common effect is a reduction of diameter growth of up to 90%. Aesthetic benefits in recreation areas and home sites are reduced. Complaints and requests for control are common during outbreaks.

It is planned to develop methods of mass-rearing adults of *Sarcophaga aldrichi* and *Pseudosarcophaga affinis* and release them in considerable numbers during the initial stages of an outbreak in selected localities. Areas where outbreaks of the host are likely to occur will be determined using the method outlined by W.G.H. Ives using weather data. Adult parasites will be contaminated with nuclear and possibly cytoplasmic polyhedrosis virus shortly before releasing them into a population (possibly by spraying them with a suspension of the viruses). Since only the early stages of the host are susceptible to the NPV, increased control from this disease would be hoped for in the generation following the spraying. Since third to fifth instar hosts are susceptible to the CPV, this disease may produce more control in the year of release. Control populations will be studied. G. R. Stairs (Can. Ent. 98:1100) sprayed virus over small areas of an infestation in 1963 and found that it had spread over 700 miles by 1965. He concluded further that

"*S. aldrichi* in the system may be essential to the rapid development of epizootics" (Ann. Rev. Ent. 1972, 17:355). The possibility of obtaining contaminated parasite adults by incorporating virus in the larval food medium will be studied.

9. Study Objectives:

1. To control outbreaks of the forest tent caterpillar in selected areas and reduce the duration and severity of outbreaks over larger areas by the introduction of large numbers of virus-carrying parasites to initiate epizootics.

2. To develop methods for mass-rearing the sarcophagids *S. aldrichi* and *P. affinis*.

10. Resources:

a. Starting date: 1973
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 3
d. Essential new major equipment items for 1974-75 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1974-75 man-years Prof. 0.0 (J. A. Muldrew)
Supp. 0.0 (R. M. Smith)
Casual ___
Total 0.0 O & M funds req'd:

11. Progress to Date:

A literature survey was carried out. Consultation was made with Dr. G. R. Stairs on various aspects of the problem. Initial rearing studies using salmon and liver and mixtures of these were carried out. Field estimates of parasitism were made in conjunction with making mass collections of cocooned forest tent caterpillar pupae to obtain parasite material.

12. Goals for 1973-74:

1. To develop laboratory rearing methods for the dipterous parasites.

2. To obtain virus material and investigate laboratory propagation.

3. To collect a supply of dipterous parasite puparia for further experimentation.

13. Accomplishments in 1973-74:

1. *Sarcophaga aldrichi* adult females commonly lived for over 60 days in oviposition cages. The highest rates of oviposition were obtained using pieces of hog liver covered by aspen leaves and placed adjacent to empty forest tent caterpillar cocoons.

In rearing, pieces of liver or liver slurry proved better than fish (salmon or northern pike) or mixtures of fish and liver.

Survival was better with raw food as compared to heat-sterilized food. Hog-liver slurry containing 0.6% formaldehyde was superior to untreated liver slurry and slurry containing 0.2%, 0.4% and 0.8% formaldehyde. Desiccation of food was a problem in both rearing parasites and obtaining oviposition and an enclosed system was constructed by which air was first brought to 70% RH and then passed through a container containing a germicidal lamp (30 watt UV) before entering the enclosed rearing chamber.

2. Larvae suspected of being killed by virus organisms were rarely found in the field and no studies were carried out utilizing virus.

3. Mass collections of forest tent caterpillar cocoons were made in Manitoba, Saskatchewan and Alberta to provide parasite material for further studies.

14. Goals for 1974-75:

Work on this study is to be held in abeyance for one year due to other commitments.

15. Publications:

Up to 1973-74

Nil

1973-74

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1974 - 75

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1974

1. Project: Reduction of damage from insects

2. Title: Control and damage impact of insects injurious to forest trees, shade and ornamental trees and shrubs.

3. New: X 4. No.: NOR 973

5. Study Leader: H.F. Cerezke

6. Key Words: Forest habitats, shelterbelts, woodlots, parks and recreational areas, plantations, seed orchards, tree nurseries, urban landscapes, pesticides, insecticides, cultural control, integrated control, growth losses, population sampling.

7. Location of Work: region wide

8. Problem:

In the prairie provinces there exists the need to examine entomological problems which arise annually and seasonally, often on short notice, and cause concern in forested areas, park and recreational areas, nurseries, shelterbelts, private wood lots and ornamental plantings in urban and rural landscapes. In most cases, such problems may only require identification of the insect organism or other causal agents, and control recommendations are made according to established procedures, such as by chemical, pruning, tree removal or no controls. The nature of the recommendations are dictated by an assessment of the hazard of the insect and its potential damage, and to some extent by the wishes of the owner(s) or forest manager. Staff of the Insect and Disease Survey and Pest Control Officers of C.F.S., and of other extention specialists of federal, provincial and municipal departments fulfill most of these needs.

Other entomological problems arise which require more comprehensive examination or short term studies. These may include population surveys in spruce budworm-infested timber, bark beetle hazard prediction, woodborer hazard in fire-killed timber, identification of causes of mortality and tree damage in plantations and natural regeneration, development of special sampling techniques to measure insect abundance and to assist pre- and post-spray application in shelterbelts,

urban and park areas, life cycle studies to establish proper timing of controls and impact studies to measure growth losses, predict long term effects on tree form, growth pattern and aesthetic value. Studies may also be initiated which can lead to new strategies of control or to increase effectiveness of control such as by integration of two or more control methods, such as with use of cultural techniques, biological agents, pheromones and other insect-specific chemicals. Opportunity may also exist to undertake field trial demonstrations for testing control procedure and long term effectiveness.

The main benefits of this study will be to advise and up-date information on insect control in new problem areas and to complement the services offered under studies NOR 033 and NOR 132. Increasing public awareness, more intensive forest management practices and increasing demands on the environment such as in park and recreational areas, have all contributed in recent years to many new and varied enquires of entomological concern. This is a vehicle study and is aimed at fulfilling the needs of special enquires.

9. Objectives:

Studies in 1974 - 75 are limited due to other commitments and are largely exploratory. Changes in objectives may be necessary next fiscal year.

(1) To establish an inventory, through literature review of the life histories, host damage and distributions of important insect pest species in the prairie provinces.

(2) To provide information on insect control, abundance, hazard and damage impact in new areas of concern to various clients.

10. Resources:

(a) Starting date: October, 1973
(b) Estimated year of completion: Indefinite
(c) Estimated total prof. man-years required:
(d) Essential new major equipment for 1974 - 75: Nil
(e) Essential new major equipment beyond 1975: Unknown
(f) 1974/75 man-years: Prof. 0.2 (H. Cerezke)
Supp. ——
O & M funds required: _____

11. Progress to date:

Approximately 1.0 man/mon. spent in gathering and reviewing information for representation at Western Committee on Crop Protection meeting (Oct, 1973), for C.F.S. representation at Pest Control Advisory Committee (Alberta) meeting (Nov, 1973) and for review and editing services of reports prepared under study NOR 132.

12. Goals for 1973/74:

N/A

13. Accomplishments for 1973/74:

(See item #11 above)

14. Goals for 1974/75:

(1) Maintain information on pesticide registrations, laboratory and field trial testings of pesticides through Plant Products Division (CDA), CCRI and various other chemical, Federal and Provincial agencies.

(2) Establish an inventory, through literature review, on the life histories, host damage and distributions of 10 - 15 priority pest species in the prairie provinces.

15. Publications:

Up to 1973/74: Nil

16. Signatures:

Investigator

Program Manager

Director

STUDY STATEMENT

1974-1975

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE Date: Feb.18/74

1. Project: Liaison and Technical Advisory Services in Forest Management.

2. Title: Technical and Advisory Services re Insect Pests and Diseases of Forests, Parks, Shelterbelts and Plantations

3. New: Cont. X 4. No.: NOR-068

5. Study Leader: V. Hildahl

6. Key Words: Tree biology, entomology, pathology, detection, insects, diseases, appraisals, protection, pesticides, chemical control, spraying, demonstrations

7. Location of Work: Manitoba

8. Problem:

Nature of study: The primary need for the study is to develop and maintain harmonious working relationships and promote effective communication with administrative, research and operational personnel associated with the fields of forestry, recreation, and amenities in order to: 1) ensure that the user agencies derive maximum benefits from results of appropriate research and development programs pertaining to tree protection, maintenance and establishment; and 2) provide feedback to research managers on the requirements and views of user agencies for the initiation of meaningful research and demonstration studies which will effectively contribute to resolving major insect and disease problems associated with forest and planted trees.

Benefits: Reduced losses in forest stands from extensive insect and disease outbreaks (especially in areas where controls can be applied), and more successful and improved amenity and shelterbelt plantings.

Probability of success: Tree failures, particularly in the semi-arid prairie regions, are primarily due to the unfavorable or marginal conditions under which they are required to grow. Often they are subjected to low moisture supply, extreme temperature fluctuations, and off-site planting. Any deviation below the average is reflected in poor tree growth, and any additional stresses caused by competition from weeds and grasses or insect and disease attacks ultimately result in serious tree injury or mortality. Proper utilization of research and demonstration results by the resource manager will contribute significantly to better tree growth.

9. Study Objectives:

Provide technical guidance and assistance to resource managers of the province in developing tree protection, maintenance and utilization programs that are in accordance with keeping tree losses due to insect and disease outbreaks within acceptable or tolerable limits.

This is accomplished by: 1) interpreting and disseminating (in the form of bulletins, special reports or personal contact) results of scientific research that have practical application in dealing with insect and disease problems: 2) evaluating current insect and disease outbreaks with respect to impact on forest stands, and park, shelterbelt and ornamental plantings; and 3) developing and co-ordinating as required large-scale control programs that are beyond the competence of resource managers.

10. Resources:

a) Starting date: 1966
b) Estimated year of completion: Continuing
c) Estimated Prof. man-years required
d) Essential new major equipment items for 1974-75: None
e) Essential new major equipment items beyond 1975. None
f) 1974-75 man-years V. Hildahl 0.7
A. Campbell 1.0
1.7

11. Progress to date:

During the period 1966 to 1975 contacts were maintained and excellent liaison developed with authorities of government and industry associated with forest utilization, reforestation, and amenity programs in the Region, and an advisory service established pertaining to providing advice on insect and disease problems in forest stands and on park, shelterbelt and amenity plantings. The study has been highlighted by: 1) the application of chemical controls for suppressing jack pine budworm outbreaks in natural stands and plantations of pine in Manitoba using aerial application equipment; 2) evaluating application techniques with ground spray equipment suitable for use by park and forestry personnel in suppressing localized outbreaks of the jack and spruce budworms in park and resort areas; 3) developing 10-year jack pine mistletoe eradication programs in the Belair Provincial Forest and Western District of Manitoba, based on market demands for jack pine; 4) testing insecticides to determine their effectiveness under field operational conditions, particularly in relation to control of outbreaks of the spruce and jack pine budworms, poplar bud-gall mite, cankerworms, and spruce sawflies; and 5) developing technical information brochures designed primarily for use by resource managers.

In 1972-73, the excellent liaison established in previous years with resource managers (including provincial, municipal, city and industrial agencies) was maintained, and technical advisory services pertaining especially to insect and disease problems was continued. The extent and severity of the spruce budworm outbreak in the Spruce Woods area was delineated, and an aerial spray program developed for the Park authorities. In addition, field appraisals were made with regard to specific insect and disease problems (including conditions in the Manipogo, Spruce Woods and Grand Beach Provincial Parks, and in The Pas-Thompson-Cowan area), operational testing of insecticides to control insect outbreaks were continued, and spray application techniques demonstrated as requested by resource managers.

12. Goals for 1973-74:

1. Maintain a high standard of liaison with resource managers throughout the provinces by providing technical advice as required.

2. Through technical advice assist in the provincial spruce budworm aerial spray program in the Spruce Woods Provincial Forest.

3. Advise on and assist with the experimental testing of Bacillus thuringiensis to determine its effectiveness as a control agent for budworms in the Spruce Woods Provincial Park.

4. Insect and disease appraisals will be conducted as required by resource managers, and provide special reports to keep them advised of current conditions and latest control measures.

5. Continue and complete spray trials re poplar bud-gall mite on hybrid poplars and publish results on same.

6. Prepare Liaison and Services bulletin outlining control techniques developed for poplar bud-gall mite - for distribution to resource managers.

7. Prepare Liaison and Services bulletin outlining control techniques for the fall and spring cankerworms - for distribution to resource managers.

8. Publish results of 1969 "Appraisal of Prairie Tree Planting" - jointly with R.M. Waldron.

9. Publish Liaison and Services bulletin re "Bibliography of Shelterbelt Research In North America - for distribution to resource managers.

13. Accomplishments in 1973-74:

1. The excellent contacts and liaison with resource managers was maintained, and technical advisory services were provided especially on current insect and disease problems. Regular contact was also maintained with Forest Insect and Disease Survey personnel assigned to Manitoba for the field season and information of mutual concern was exchanged.

2. Technical advice was provided during the spray program to prevent spruce budworm damage in the Spruce Woods Provincial Park and Forest. Field data were collected in conjunction with the program and a preliminary report, summarizing the effect of the aerial spraying, was submitted to the Manitoba Department of Tourism, Recreation and Cultural Affairs for the attention of the Clean Environment Commission.

3. Responsibility for experimental testing with Bacillus thuringiensis was assumed by Dr. R.F. DeBoo, Chemical Control Research Institute, Ottawa, in order that results could be correlated with a national study.

4. Insect and disease problems in the Manipogo, Spruce Woods and Grand Beach Provincial Parks as well as in The Pas-Thompson-Cowan area were appraised and appropriate reports provided to the requesting agency.

5. Spray trials (insecticides) pertaining to poplar bud-gall mite were completed, and a publication on results is in early stages of preparation.

6. Proposed bulletin outlining control techniques developed for poplar bud-gall mite in first stages of preparation (in cooperation with Dr. R.F. DeBoo, Chemical Control Research Institute, Ottawa).

7. Proposed bulletin outlining techniques for the control of the spring and fall cankerworms is in preparation.

8. "Appraisal of Prairie Tree Planting" data collected in 1969 has been analyzed and a journal publication entitled " Impact of Farmstead Abandonment and Lack of Cultural Management on Shelterbelts and Related Amenity Values in Saskatchewan" is in process of being submitted to Forestry Chronicle for publication.

9. "Bibliography of North American Shelterbelt Research" is in final stages of preparation; review copy has been typed.

14. Goals for 1974-75:

1. Continue to maintain a high standard of liaison with resource managers throughout the province, and provide a technical advisory service with regard to insect and disease problems in forest, urban and rural environments.

2. Conduct insect and disease appraisals as requested by resource managers, and provide appropriate reports on current conditions.

3. Continue assessment of pesticides to determine their efficacy under operational conditions; this will include fall cankerworm in southern Manitoba, yellow-headed spruce sawfly in central Manitoba, and spruce budworm in Spruce Woods area.

4. Publish scientific paper entitled "Evaluation of Insecticides for Control of Cankerworms in Manitoba"(with Dr. R.F. DeBoo, Chemical Control Research Institute, Ottawa).

5. Publish results of Spruce Woods spray program with Dr. R.F. DeBoo, Chemical Control Research Institute. Proposed title of publication "Evaluation of Aerial Spray Applications of Insecticides Against Spruce Budworm in the Spruce Woods Provincial Park and Forest, Manitoba."

6. Complete brochure entitled "Cankerworms in the Prairie Provinces".

7. Complete journal publication entitled "Impact of Farmstead Abandonment and Lack of Cultural Management on Shelterbelts and Related Amenity Values in Saskatchewan".

8. Publish scientific paper entitled "Control of Poplar-Bud Gall Mite with Insecticides" (with Dr. R.F. DeBoo, Chemical Control Research Institute, Ottawa).

15. Publications:

1973-74: Nil

Up to 1973: See attached appendix.

16. Signatures:

Program Manager

Investigator

Director

APPENDIX I

Up to 1972-73:

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

b) 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.

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

d) Hildahl, V. and J.G. Laut. 1969. Management Control of Jack Pine Mistletoe in the Belair Provincial Forest of Manitoba. Canada Dept. of Fisheries and Forestry, Liaison and Services File Report. 9 p.

e) 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.

f) 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.

g) 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.

h) Hildahl, V. 1970. Windbreak and Shelterbelt Protection. In Proceedings Western Canadian Society for Horticulture. File Report NOR-Y-38. 16 p.

i) Hildahl, V. 1970. Summary of Tree Planting on the Canadian Prairies for 1903-1969. File Report NOR-Y-42. 9 p.

j) DeBoo, R.F. and V. Hildahl. 1971. Control of the Jack-Pine and Spruce Budworms with Ground Application Equipment in Manitoba. Manitoba Entomologist. 5:57-67.

1972-73:

Roller, K.J., D.H. Thibault and V. Hildahl. 1972. Guide to the Identification of Poplar Cultivars on the Prairies. Dept. of Environ., Can. For. Ser. Publication No. 1311. 55 p.