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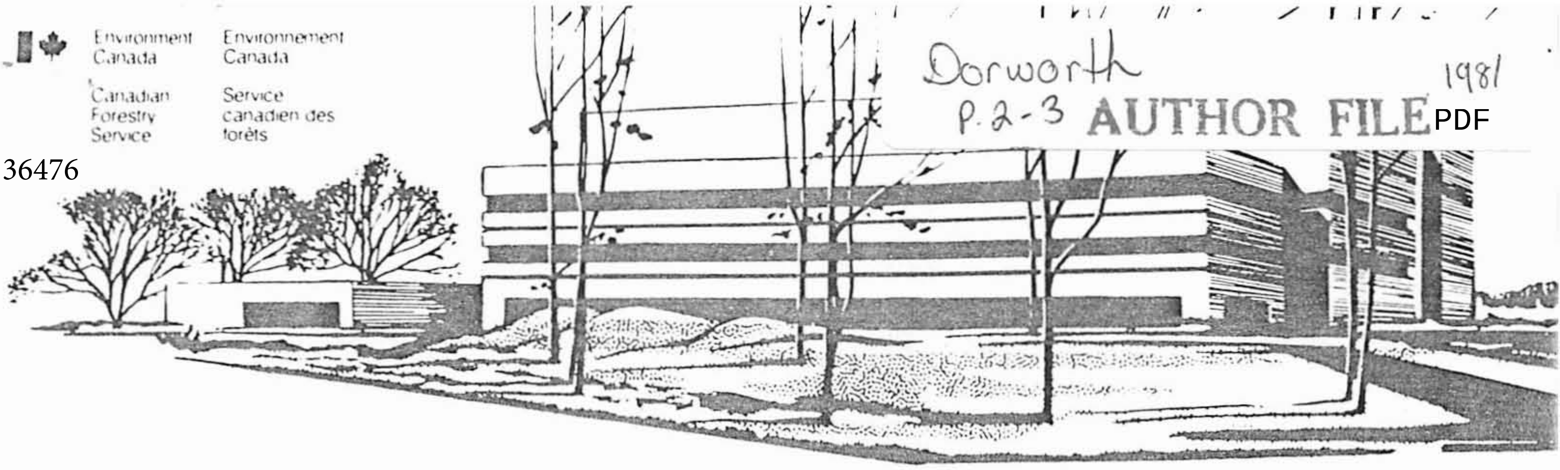


FORESTRY RESEARCH NEWSLETTER

GREAT LAKES FOREST RESEARCH CENTRE, SAULT STE. MARIE, ONT.

Fall-Winter 1981

THE NATURAL ENEMIES OF THE GYPSY MOTH IN CANADA

The gypsy moth, *Lymantria dispar* (L.), was accidentally introduced into Massachusetts in 1869. It is now found in the United States throughout the New England states, New York, New Jersey and Pennsylvania and has also been recorded in the adjacent states of Delaware, Maryland, Virginia and West Virginia. Isolated infestations have been recorded in Washington, Oregon, California, Michigan, Wisconsin, Illinois and Ohio. The continuously infested area reached the province of Quebec, south of Montreal, around 1959, and the province of Ontario, on Wolfe and Howe Islands, near Kingston, in 1969 and 1970. It is now found in Quebec more or less continuously on the south shore of the St. Lawrence River westward from approximately 50 km west of Quebec City, north along the Ottawa River to Ottawa, and in Ontario south and east of a line from Ottawa to Belleville. Isolated infestations were found in 1978 in Vancouver and in 1980 in Greater Toronto.

Gypsy moth female and egg mass, Kaladar, Ontario

Since its introduction into North America, the gypsy moth has had many periodic outbreaks and caused defoliation over large areas. In 1980,the worst year for defoliation to that time, 2,000,000 ha of forest were severely defoliated in the eastern United States. In 1981 the area of severe defoliation is between 3,500,000 and 4,000,000 ha. According to a recent article in Science (Marshall, E. 1981. The summer of the gypsy moth. Science 213:991-993) defoliation is expected to be greater in 1982 and dispersal is expected to continue until all eastern U.S. oak forests have been infested. We know of no reason why this insect should not spread in the same manner in Canada, although, because stand compositions here are not the same as in the United States, there is no certainty that the defoliation will be as severe.

Work on this pest in the United States began shortly after its introduction and has gone on continuously since, with an especially large effort being made in the past decade. Although it is obvious that this work has not prevented destruction by or dispersal of the gypsy moth, much information on its natural enemies was obtained. It was determined from these studies that there are 26 species of native insect parasites and 17 species of native insect predators attacking the gypsy moth in the United States. In addition there are four species of mammals and 46 species of birds that prey on it.

Part of the suppressive work in the United States consisted of a massive program of parasite and predator introduction, carried on from 1905 until 1933, in which 44 species of parasites and nine of predators were released. Biological control work has been renewed in the past decade: eight species of parasites and one species of nematode have been released. Four of these parasites were species that had been released unsuccessfully in the earlier work, and this suggests that the reservoir of new candidates for release may be nearly empty. Thirteen exotic parasite species and one predator species were established from the early biological control work. However, of this complex of 57 natural insect enemies, only two of the native parasites, eight of the exotic parasites and one of the exotic predators are common enough in outbreaks in the United States to be considered important. They have obviously not been able to prevent the spread of the gypsy moth, but, in areas where the gypsy moth is undergoing its first outbreak since its arrival, it is believed that they may be initiating gypsy moth population collapses and maintaining relatively stable infestations in many areas following a

STAFF APPOINTMENTS

Arthur Groot

Timothy J. Lynham

Mr. Arthur Groot joined the staff of the Great Lakes Forest Research Centre in August, 1981 as a forestry officer with the Black Spruce Ecosystem Silviculture project. Originally from Oshawa, Mr. Groot is a 1979 graduate of the University of Toronto, where he obtained his B.Sc. in forestry. He is currently working on his M.Sc. in forestry at Lakehead University in Thunder Bay. During the summers of 1976-1978 Mr. Groot was employed by the Ontario Ministry of Natural Resources.

Mr. Timothy J. Lynham is the newest member of the Centre's Forest Fire Research project. From 1973 to 1974 Mr. Lynham worked for the Arthritis Research Group of Imperial Chemical Industries in Manchester, England, and in the latter part of 1974 he joined the Heart Disease Research Group at McMaster Medical Centre in Hamilton. In 1978 he obtained his B.Sc. in forestry from Lakehead University in Thunder Bay. From 1978 to 1979, as a project forester with the Aviation and Fire Management Centre, Ontario Ministry of Natural Resources in Sault Ste. Marie, Mr. Lynham was assigned to the LANDSAT and computerized lightning project. Prior to joining the staff of the Great Lakes Forest Research Centre, he worked as an image analyst for INTERA Environmental Consultants in Ottawa.

SPECIES AND RACE CHARACTERIZATION WITHIN THE GENUS *GREMMENIELLA*

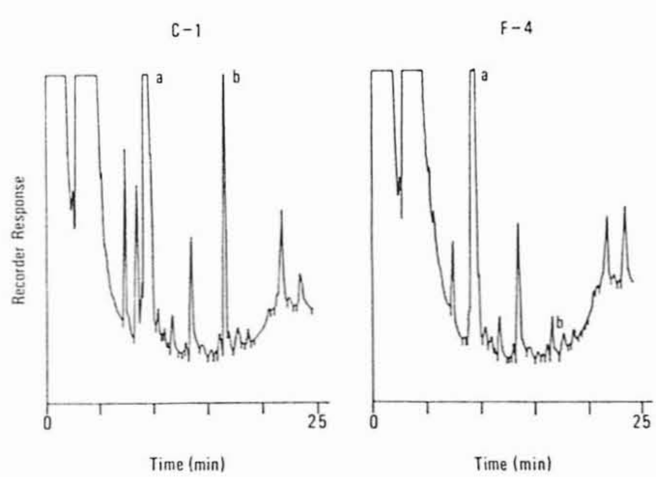
The pathogenic fungus *Gremmeniella abietina* was described by Torsten Lagerberg in Norway nearly 70 years ago as *Grumenula abietina*. Even before that time, Europeans were familiar with the damage caused by this fungus, although the name of the asexual state *(Brunchorstia pinea)* was the one most often employed. The situation that prevailed in North America during the 1940s and 1950s was similar in many respects. Pathologists and foresters were aware of a pine disease termed Jones' disease or X disease, and included within descriptive categories such as "plantation failure," for two or more decades before *G. abietina* was found associated with the disease and properly identified. This was accomplished by Professor Eric Jorgensen who was then attached to the Canadian Forestry Service and is now with the University of Guelph.

In the 1970s it became apparent that separate though overlapping disease syndromes were described from Europe and North America, although each was attributed to the pathogen *G. abietina*. Furthermore, a far broader host range was known to be associated with the pathogen in Europe than could be distinguished in North America. These points were outlined in detail in the Spring 1978 issue of the Forestry Research Newsletter.

By the early 1970s a serologic technique had been developed at the Great Lakes Forest Research Centre and the Forest Pest Management Institute in Sault Ste. Marie whereby several races of *G. abietina* could be differentiated. A disease syndrome comparable with that in Europe was noted in the state of New York about the same time, and the serologic technique was used to distinguish this pathogen as one comparable with the European race of *G. abietina*.

Thereafter, on the basis of the Canadian Forestry Service system, quarantines were enacted to constrain import and internal movement of the European race of *G. abietina* in both Canada and the United States. Difficulties promptly arose in that the serologic technique from which the *G. abietina* race system devolved required specially trained personnel and equipment not generally available in forest disease laboratories. In due course, however, these difficulties were overcome and a mass-screening procedure was developed in the United States at the USDA Forest Service Laboratory in St. Paul, Minnesota. Valuable contributions were made as well by researchers at Cornell University, the universities of Vermont, Wisconsin, Minnesota and New York at Syracuse, and the New York Department of Environmental Conservation. Similar work was initiated at the Great Lakes Forest Research Centre when it became evident that the European race of *G. abietina* was present in the provinces of Quebec and New Brunswick and, more recently, in Newfoundland.

It quickly became evident, however, that the serologic technique did not supply positive identifications quickly enough to satisfy the requirements of everyone who might use the information. This was particularly true in the case of regulatory personnel and agencies, such as the Plant Quarantine Division of Agriculture Canada and its United States counterpart, APHIS. A search was undertaken intermittently over approximately two years to identify a more rapid technique that would reflect in its results the extant race system used to identify races of *G. abietina*.



Chromogram of metabolic extracts of one North American race isolate (C-1) and one European race isolate (F-4) showing two peaks (a and b) which usually differ significantly in two races as indicated by their peak area ratios.

Workers at the Great Lakes Forest Research Centre reviewed a number of techniques that had proved inadequate for this purpose in the past, in the hope of refining these techniques and perhaps developing new ones. Column chromatography, disc-gel electrophoresis and spectrophotometry, as well as a variety of spot tests and other gross chemical identification procedures were reviewed, adapted as seemed appropriate, and applied to the problem. In each instance, the tests either generated too great a degree of variation to be of real value or produced results that failed to conform with the existing race structure.

Gas-liquid chromatography in several variations failed to identify qualitative variation among the races of *G. abietina*. Known European race isolates did differ quantitatively from those of the North American race in most instances, however, when the peak area ratios of two variable peaks were compared. Unfortunately, although the results were generally consistent and reproducible, several standard isolates failed to conform with the race characterization pattern achieved through serology. Possibly, gas-liquid chromatography can permit identification of a race system for *G. abietina* that will be of greater biological significance than the one described through the use of serology. This is a separate matter, however, and it was decided that erection of a separate race system or even detailed elaboration of results without exhaustive testing would merely confuse the situation.

The problem has not been abandoned. In fact, workers at the Forest Pest Management Institute report encouraging preliminary results using immunoelectrophoresis, membrane filter serology, acrylamide gel techniques and the ELIZA technique, and other types of research are under way as well. A brief review of the problem yields the following points:

1) A simpler and more rapid technique would be a valuable adjunct to existing research work if it served to lessen the six- to eight-week period currently required between field identification of *G. abietina* and laboratory race characterization.

2) Regulatory agencies, particularly the Plant Quarantine Divisions of each affected country, require a rapid, simple, and accurate means of differentiating races of *G. abietina* in order to apply existing quarantine statutes in efficient, uniform fashion. The U.S. Plant Quarantine Division (APHIS) noted this problem in its decision to rescind the existing United States quarantine.

3) There is a limit to available funds, and to the time which trained staff can devote to this work.

4) Our present information about worldwide distribution of *G. abietina* is limited to North America, to reports from Europe and Japan, and to laboratory results with isolates of *G. abietina* provided by scientists from those areas. It is quite possible that the pathogen exists in South and Central America and in Africa as well, in areas where climate and host disposition are amenable to development of the fungus. If so, any race system we develop at this time is open to restructuring as further information becomes available.

The possibility that the pathogen has spread to other continents is not a problem in the scientific sense, in that any such system is open to change or replacement as the available information and our understanding of the system increase. Nevertheless, a balance must be maintained between scientific flexibility and the requirement of statutory boards for a stable system of organism identification on which to base legal decisions. The capacity to make consistently accurate legal decisions based upon currently available technology could become particularly important in cases where litigation ensued following a decision. The current *G. abietina* race system as originally described at the Great Lakes Forest Research Centre meets this requirement, in that it permits dependable characterization of three races of *G. abietina* by a technique that can be utilized concurrently in separate laboratories to provide verification of results. Diagnosis of the race involved in an outbreak of Gremmeniella disease will permit the management forester to estimate potential impact and determine the extent and type of corrective measures that are necessary.

Specific information on testing procedures and analysis of fungus races can be obtained by contacting the Information Office at the Great Lakes Forest Research Centre.

-- *C. E. Dorworth*

LRTAP UPDATE
TURKEY LAKE FOREST WATERSHED

A project on the long-range transport of air pollutants (LRTAP) has been set up in the Turkey Lake Forest Watershed, a small watershed about 50 km north of Sault Ste. Marie located in an old-growth hard maple-yellow birch forest. A chain of four lakes, the last one in the system being Turkey Lake, discharges into the Batchawana River and then into Lake Superior. Precambrian greenstone is the predominant bedrock, and there are some granite outcrops, especially in the headwater area.

The Great Lakes Forest Research Centre (GLFRC) of the Canadian Forestry Service (CFS) is primarily responsible for the terrestrial portion of the multi-agency integrated LRTAP study being conducted at Turkey Lake. CFS efforts are directed mainly at following the biogeochemical cycle from precipitation through the vegetative canopy and the soil system and then to the small feeder streams which empty into the major connecting waterways and lakes of the aquatic system. Also included in the study is measurement of the organic matter cycle and biomass accumulation in the standing crop.

At present, 20 small basins have been delineated within the main watershed; control structures for continuous monitoring of streamflow have been installed on 14, while the other six are measured periodically. Samples from these small streams are collected weekly and returned to the laboratory in Sault Ste. Marie for chemical analysis. The analysis covers about 25 parameters including pH, conductivity, alkalinity, nutrients, major ions and trace metals. This provides a measure of the quality of the water as it leaves the terrestrial and enters the main aquatic system. Most of these small streams are primarily surface runoff but a few appear to have a groundwater component. The information gained from this study and the studies of the National Hydrology Research Institute of the Inland Waters Directorate should indicate groundwater quality in the watershed.

Soil water movement through the organic and mineral soil horizons of the maple-birch forest is an integral part of the biochemical cycle studies. Because of unbalanced charges on soil minerals and organic matter, soils retain metal ions released by mineral weathering and organic matter decomposition. It is the interaction with these metal ions that determines how the chemical nature of precipitation will change as it percolates through the soil. The chemistry of the soil solution is important not only to the flux of ions moving to the streams and lakes, but also to tree nutrition and microbial growth.