A history of mycology in Canada

RALPH H. ESTEY

Department of Plant Science, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, QC H9X 3V9, Canada

Received December 21, 1993


This brief history of mycology in Canada has comments on the activities of more than 200 men and women. Emphasis is on those aspects of mycology in which Canadian mycologists, plant pathologists, forest pathologists, and geneticists have pioneered or excelled. It includes their studies on fossil fungi, aeronomyology, the identity of wood destroying fungi in their mycelial stages, the coevolution of parasitic fungi and their host plants, mycotoxicology, psychrophilic fungi, predacious fungi, fungal genetics, and mycorrhizae, in addition to systematics, numerical taxonomy, and the use of computers in mycology.

Key words: fossil fungi, fungal genetics, coevolution, predacious, mycorrhizae, taxonomy.


Cette brève histoire de la mycologie au Canada fait état des activités de plus de 200 hommes et femmes. L’auteur met l’emphase sur les aspects de la mycologie dans lesquels les mycologues, les pathologistes des végétaux, les pathologistes forestiers et les généticiens canadiens ont été innovateurs ou ont exceller. Ce document inclut leurs études sur les champignons fossiles, l’aéromycologie, l’identification des champignons ravageurs du bois à l’état mycelien, la coévolution des champignons parasites avec leurs hôtes, la mycotoxicologie, les champignons psychrophiles, les champignons prédateurs, la génétique des champignons et les mycorhizes, en plus de la systématique, de la taxonomie numérique et de l’utilisation des ordinateurs en mycologie.

Mots clés : champignons fossiles, génétique des champignons, coévolution, prédateurs, mycorhizes, taxonomie.

[Traduit par la rédaction]

Introduction

This review is about mycology in Canada and not just about mycologists, of whom there have been very few. In fact, there were no more than three officially designated mycologists in all of Canada until 1950. Their numbers increased to a high of about 20 in 1963, then slipped down to approximately 14 in 1994. Most of the work in mycology has been, and continues to be, performed by persons listed in their places of work as botanists, geneticists, microbiologists, plant pathologists, etc. Approximately 130 plant pathologists are studying fungal-induced diseases in 1994 and are therefore “applied mycologists.” This brief history includes all known mycologists but only such others, mostly plant pathologists, who have taught mycology, named a new fungal taxon, or otherwise made a contribution to mycology. It does not include medical mycology.

A comprehensive history of mycology in Canada is yet to be written. However, the book by R.H. EsteY, Essays on the History of Early Plant Pathology and Mycology in Canada (46), has a fully referenced account of mycology in this country up to 1950. It includes references to the first book devoted to fungi published in Canada, to the first published records of fungi collected in each of the provinces and territories, and to the pioneering work of many outstanding men and women who laid the foundations for modern mycology in Canada. Some of those individuals are known to virtually all mycologists and their activities have been well documented. Others whose mycological activities in Canada were outlined by EsteY (46) include Adaline and Mary van Horne who collected fungi in the vicinity of St. Andrews, New Brunswick, between 1895 and 1908; Hans T. Gussow (1879–1961) who as Dominion Botanist continued and greatly expanded the work begun by Fletcher and initiated the collection of fungi that became the National Mycological Collection in Ottawa; John W. Eastham (1880–1968), Gussow’s first trained assistant in plant pathology, who collected slime molds as a hobby; Canada and was the first federally employed botanist to publish on fungi; John Dearness (1852–1954), a centenarian whose mycological activities spanned a period of more than 70 years and who was the first Canadian-born president of the Mycological Society of America; James Fletcher (1852–1908) who set the stage for mycological studies in the federal department of agriculture; William P. Fraser (1867–1943), the first Canadian-born professional mycologist and specialist on rust fungi; and A.H.R. Buller (1874–1944), Professor of Botany at the University of Manitoba from 1904 until 1936, who became the best known of the early mycologists in Canada. Buller’s students include such well-known mycologists as Harold Brodie (1907–1989), a world authority on the Bird’s Nest Fungi; Dorothy Newton (later Dr. Dorothy Swales), who made some pioneering studies on sexuality in species of Coprinus and in 1923 was the first woman to be awarded the Ph.D. degree by the University of Manitoba, William Fielding Hanna (1892–1972) a pioneer in the field of fungal genetics; and Guy Richard Bisby (1889–1958) the well-known co-author, with G.C. Ainsworth, of Ainsworth & Bisby’s Dictionary of the Fungi, but who is not as well known as Buller’s colleague at the University of Manitoba from 1920 until 1937, and the principal author of two books, Fungi of Manitoba and Fungi of Saskatchewan (16, 17).

Others whose mycological activities in Canada were outlined by EsteY (46) include Adaline and Mary van Horne who collected fungi in the vicinity of St. Andrews, New Brunswick, between 1895 and 1908; Hans T. Gussow (1879–1961) who as Dominion Botanist continued and greatly expanded the work begun by Fletcher and initiated the collection of fungi that became the National Mycological Collection in Ottawa; John W. Eastham (1880–1968), Gussow's first trained assistant in plant pathology, who collected slime molds as a hobby;
Frank L. Drayton (1892–1970) who succeeded Eastham and became known for his research on the Sclerotiniaceae; Alan W. McCallum (1893–1967), Canada's first official forest pathologist (in 1920), who collected fungi from Quebec and southern British Columbia; Herbert S. Jackson (1883–1951), Canada's first university professor of mycology at the University of Toronto; Clara W. Fritz (1889–1974) whose doctoral thesis provided a key for the identification of wood-destroying fungi in culture; and Irene Mounce (1894–1987) who was well known for her pioneering studies on mating systems of wood-destroying Hymenomycetes.

Dozens of lesser known people who contributed to the development of mycology in Canada are also included in Estey's account.

**The Central Experimental Farm, Ottawa**

Since the early 1920s, most Canadian mycology has been centered around the Central Experimental Farm (CEF), Agriculture Canada, Ottawa. The early work there has been succinctly told by Cody et al. (31).

Ibra L. Conners (1894–1989) went there in 1929 after having worked for the federal Department of Agriculture in western Canada for several years, including some time with W.P. Fraser. It was Conners' flair for mycology that led to his transfer to Ottawa to be curator of the fungus collection that became the National Mycological Herbarium in 1932. He also took charge of the Canadian Plant Disease Survey, which he headed with distinction until 1956. Although Conners officially retired in July 1962 after more than 40 years of service in the Department of Agriculture, he continued to work on *An Annotated Index of Plant Diseases of Canada and Fungi Recorded on Plants in Alaska, Canada and Greenland*, which was published in 1967 (33). This was soon acclaimed as the most useful and important book on plant diseases in Canada. He also compiled and edited a history entitled *Plant Pathology in Canada*, published in 1972 (34).

Ruth Macrae (1903–1993) went to Ottawa in 1931 to assist Irene Mounce with her pioneering work on culture studies of wood-destroying fungi. Macrae had two degrees from McGill University and had been Buller's research assistant for 3 years. She took a leave of absence to study for a Ph.D., awarded by the University of Toronto in 1941. From about 1945 and for the next decade or more, Dr. Macrae was in charge of the elm disease culture work in Ottawa. She was assisted by Ruth (Horner) Arnold (1923–1978) whose 1948 M.Sc., directed by Dr. A.R. Walker at The University of Western Ontario, involved culture studies on species of *Hypoxylon*. Arnold joined the Ottawa group in 1952 and undertook a study of fungi found on dead or dying birch after the birch tree dieback disease became a problem in eastern Canada. As part of that work she described *Diaporthella alleghaniensis* as a new species (3). Ruth Arnold died before completing the identification of several species of *Hypoxylon* sent to her by two South American mycologists who later named *H. arnoldiae* in her memory.

Douglas B.O. Savile earned a Ph.D. at Michigan, then served in the Royal Canadian Air Force before becoming Assistant Curator of the National Mycological Herbarium from 1943 until 1953 and then Curator until 1967. His more than 100 scientific publications reflect his interests in such diverse fields as the taxonomy and biogeography of phanerogams, floristics of the Arctic, ornithology, meteorology, microscopic techniques, the cytology and taxonomy of fungi, and the principles and processes of evolution. (See also Fungal genetics.) In recognition of his wide-ranging contributions to biology, Savile was awarded the George Lawson Medal of the Canadian Botanical Association, was made a Fellow of the Royal Institute of North America, and was made a Fellow of the Royal Society of Canada. In 1978 McGill University conferred on him an honorary D.Sc., and 10 years later he was honoured by the Mycological Society of America with their Distinguished Mycologist Award. Although he has made detailed revisions of various systematic rust and smut complexes, his main contribution to mycology has been in studies of coevolution of plants and their parasitic fungi, work that began long before the term coevolution came into common use (144). Savile retired in 1974 but continues to do research as an Emeritus Research Assistant.

Mildred Nobles (1903–1993) was appointed Assistant Botanist and Plant Pathologist, Dominion Department of Agriculture, in 1935 and rose through changes in her official title to Principal Mycologist in 1959. Within a year of her original appointment she began to develop methods to identify mycelial stages of wood-destroying fungi growing in culture dishes. Although built upon the pioneering work of Clara Fritz, whose thesis she had seen in Toronto, Nobles developed her own distinctive methods. Her identification manual, published in 1948, and her 1971 *Cultural Characters as a Guide to the Taxonomy of the Polyporaceae* (118) became models of their type. Dr. Nobles was elected Fellow of the Royal Society of Canada in 1963 and retired in 1969. She was awarded the George Lawson Medal of the Canadian Botanical Association in 1972, and the Mycological Society of America awarded her the title Distinguished Mycologist in 1986.

John A. Parmelee went to Ottawa to work with Conners in 1949. He interrupted his career to obtain an M.A. from the University of Toronto in 1952 under H.S. Jackson and a Ph.D. from the University of Toronto in 1961 under Roy F. Cain. Parmelee's research revolved around obligate parasitic fungi and included taxonomic, distributional, and life-history studies of rusts, especially *Gymnosporangium* (129), smuts, and powdery mildews. Fieldwork took him across the continent and from the most southerly point in Canada to the Arctic Ocean and several of the Arctic Islands (130). He was Assistant Curator of the National Mycological Herbarium until he succeeded Savile as Curator in 1967 and continued as such until he took early retirement in 1987. Parmelee continues to work as an Honorary Research Associate.

In the late 1940s the Government of Canada centralized the mycological work of plant pathologists and forest pathologists and thus obviated the need for more than one fully representative collection of fungi and one mycological library. In 1951 several pathologists were designated mycologists and organized as a Mycology Section in Ottawa, under the direction of James Walton Groves (1906–1970).

For the next decade or more, the history of mycology in Canada was largely a history of that Mycology Section because within a remarkably short time it contained more mycologists concerned with taxonomic problems than any similar unit anywhere in the world.

The Mycology Section is now (1994) within the Centre for Land and Biological Resource Research of Agriculture Canada, formerly the Biosystematics Research Centre, which evolved from the original Dominion Department of Agriculture Laboratories. Mycologists there today continue to think of themselves as members of a mycology section or simply a mycology group. For simplicity, those terms will be used.

J.W. Groves had joined the staff of the Botany Division of...
the Dominion Department of Agriculture in 1936. He continued studies of the Discomycetes, begun during his Ph.D. work in Toronto, and published monographs on the genera *Dermea*, *Durandiella*, *Godronia*, *Pragmospora*, and *Tymanpis*. Groves worked for a while with Drayton on Sclerotiniaceae, but wartime production problems with vegetables and field crops got him involved in studies of seed-borne fungi. From 1943 to 1946 he was assisted in these studies by plant pathologist Arthur J. Skolko (1912–1989) and for some time after 1946 by Mary Elliott (1923–1976), a graduate of Queen’s who was becoming an authority on the Sclerotiniaceae before her tragic death. Skolko’s work with seed-borne fungi led, in 1953, to his appointment as Chairman, Plant Disease Committee of the International Seed Testing Association. He retired in January 1973.

Skolko was aided in the seed research by plant pathologist Victor R. Wallen, whose three degrees were from McGill University and who was soon publishing on species and races within the genus *Ascochyta* (160) and continued to do so until shortly before he retired in 1980.

Constance (Loveland) Bowerman, whose 1951 thesis for the M.A. at the University of Toronto was entitled *Morphological and cytological studies on some species of Botrytis*, also worked with Groves on the Sclerotiniaceae and published with him on the life cycle of *Sclerotinia* (*Botryotinia*) *fuckeliana*. She made some independent studies on the Gasteromycetes and described 21 species of *Lycoperdon*, one of which was new (24).

Sheila (Hoare) Thomson, Barbara Maxwell (108), Doreen (Wells) Wilson, and Maria Pantidou, plus two or three others, were members of the Groves group for varying brief periods. Dr Wells, Assistant Mycologist, co-authored papers with Groves and in 1954 published on *Ascocybe*, a new genus of the lower Ascomycetes (162). Dr Pantidou made valuable contributions with her studies on 50 species of the Boletaceae in the 1960s. This work culminated in a joint publication with Groves (125), who had a long-time interest in mushrooms and published useful guides for mushroom collectors, especially his 1962 book *Edible and Poisonous Mushrooms of Canada* (62).

In more or less chronological order, the next mycologist to join the Mycology Section was Stanley J. Hughes, a Welshman and graduate of the University of Wales who had worked for several years with E.W. Mason at the Commonwealth Mycological Institute (CMI) and acquired an exceptional knowledge of conidial fungi and conidiogenesis. Hughes was Groves’ first recruit in 1952, and within a year he proposed an entirely new classification of the Hyphomycetes, one based primarily on the structure of conidiophores. His 1953 paper *Conidiophores, conidia, and classification* (81) became a Citation Classic of the Institute for Scientific Information. It soon became apparent to Hughes that a great many names given to conidial fungi described in the late eighteenth and early nineteenth centuries had never been fully explained. To clarify that situation, he spent 8 months examining type collections in various European herbaria and published the results of that study in 1958 (82). A Senior Research Fellowship from DSIR New Zealand enabled Hughes to spend 1963 collecting microfungi in that country. This was followed by a series of publications on New Zealand fungi.

Hughes provided the inspiration for, and was the first editor of, the publication *Fungi Canadensis* and was awarded the Jakob Eriksson Gold Medal at the International Botanical Congress of 1969 in recognition of his outstanding contribution to a better understanding of the Hyphomycetes. He was elected President of the Mycological Society of America, and his presidential address was largely a review of his studies on sooty moulds (83). Hughes became a Fellow of the Royal Society of Canada (1974), was awarded the George Lawson Medal by the Canadian Botanical Association (1981), and received the Distinguished Mycological Award by the Mycological Society of America (1985). He was made an honorary member of the British Mycological Society in 1987 and is one of only 50 elected Honorary Foreign Members of the Linnean Society of London. Although officially retired in 1983, Hughes continues to pursue mycological interests as a hobby. Since retiring, he has published on pleomorphy in some hyphopodiate fungi, and his monograph on *Meliolina* is scheduled to be published during 1994.

Toronto-born Robert A. Shoemaker joined the Ottawa group as Assistant Mycologist in 1955, the year in which he earned his Ph.D. from Cornell University. Shoemaker succeeded Groves as head of the Mycology Section (1967–1983) and became noted for his work on the Pyrenomycetes and Pleosporales. In 1992 he and Carolyn E. Babcock, Curator of the nearly 10,000 cultures in the National Culture Collection of Fungi and Nonmedical Bacteria, published on genera of applanodictyosporous Pleosporales (148). As has become common among Canadian mycologists, official retirement seems to have had little effect on Shoemaker’s research efforts.

The noted American mycologist Howard E. Bigelow, University of Massachusetts, was employed for a period in 1957 as a Professional Consultant to the Mycology Section. His work in the Section resulted in the publication of *Notes on fungi from northern Canada. IV. Tricholomataceae* (14).

In 1957, Luella K. Weresub (1918–1979), who earned her Ph.D. under the direction of H.S. Jackson and after his death, Roy F. Cain at the University of Toronto, joined the group as a research officer to study the resupinate hymenomycetes. Luella’s knowledge of botanical nomenclature was phenomenal, especially as it applied to fungi. She was a member of the Nomenclature Committee of the Mycological Society of America and of the International Mycological Association, and several of her publications reflect her ability in this field (163). Her influence on Canadian mycology and her concern with public education are recognized in the Canadian Botanical Association’s annual Luella K. Weresub lecture in Mycology and the $1000 Weresub Prize awarded annually for the best paper published by a Canadian student in mycology.

Bryce Kendrick, who came to Canada from Liverpool, England, in 1958, worked in the Ottawa laboratory on a postdoctoral fellowship with Hughes. He spent the next 6 years with the Mycology Section working mostly on Hyphomycetes and the breakdown of leaf litter. In 1965 he was appointed Assistant Professor at the newly founded University of Waterloo, Waterloo, Ont. (see below).

Trinidad-born Clarence Madhosingh worked with Groves in 1960. He spent a postdoctoral year at the Biochemistry Institute, University of Uppsala, Sweden, and organized a symposium on *Prospects in Experimental Mycology* at the first International Mycological Congress in 1971. In 1974 Madhosingh was appointed Head, Agricultural Microbiology Section, Agriculture Canada, Ottawa, and then transferred in 1982 to Agriculture Canada’s Research Centre in London, Ont. His 50 or more publications, including ones co-authored with Mildred Nobles, Victor Wallen, and James Girms, cover a broad spectrum of mycology and microbiology but with recent emphasis on species of *Fusarium*.

Grant D. Darker was with the Ottawa group from 1960 until
1969, the last 4 years of which he was doing postretirement work for the Canadian Forestry Service. Darker spent most of his career in the United States, although he collected fungi extensively in North America and in Europe. While in Ottawa he published a revised edition of his work on the genera of the Hypodermataceae (42).

Michael P. Corlett joined the group in 1965 after completion of his Ph.D. at the University of Toronto, and for 10 years he worked on the histology, morphology, and ontogeny of various fungi, mostly Ascomycetes. Since about 1975 he has studied the taxonomy of selected groups of pyrenomycetous Ascomycetes and participated in a research program on allogenic fungi. Corlett’s 1981 taxonomic survey of some species of Didymella and Didymella-like species (36) and his 328-page annotated list of the published names in Mycosphaerella and Sphaerella (37) are excellent.

Donald J.S. Barr was a doctoral student of C.J. Hickman at the University of Western Ontario before he too joined the Ottawa group in 1965. After some early work on new isolation and culture procedures for chytrids, Barr developed a fundamental reclassification of the Chytridiomycota, based primarily on zoospore cytology, and became the acknowledged authority on those fungi (8). He extended his studies to the motile cells of other zoosporic fungi and the phylogeny of protists. In 1990 he was elected President of both the Mycological Society of America and the International Society for Evolutionary Protistology. For more than two decades Barr has identified Pythium and Phytophthora cultures for plant pathologists all across the country, and this resulted in a number of collaborative projects and publications. He is one of the very few mycologists anywhere who has published on most of the known vectors of fungal viruses, and he has also published on fungi in the rumen of herbivores.

There was a 2-year interval before Kris A. Pirozynski joined the group in 1967, following an 8-year stint with the CMI. Pirozynski has published extensively on the coevolution of fungi with plants and animals and on fossil fungi. From 1975 to 1993 he was Curator of Fossil Fungi, Canadian Museum of Nature, Ottawa, where his major research interest was the role of symbiosis in the evolution of plant diversity. Two recent examples from his more than 100 papers and books include one on the geological history of the Glomaceae with Y. Dalpé (135) and a book on the coevolution of fungi with plants and animals, coedited with D.L. Hawksworth (136).

Following the retirement of Ruth Macrae in 1968 and Mildred Nobles in 1969, James H. Ginns was recruited from the College of Forestry, State University of New York, Syracuse, where he studied under J.L. Lowe, to continue work on the taxonomy of wood-destroying fungi. Ginns is well known for his 1980 monograph on the genus Coniophora, and among plant pathologists, for his 416-page reference book Compendium of Plant Disease and Decay Fungi in Canada that was published in 1986 (55). More recently he has published the Lignicolous Corticoid Fungi (Basidiomycota) of North America and a paper on Phlebia pallida (57, 56). The underlying theme in his work has been to facilitate the identification of unnamed specimens and the synthesis of widely scattered literature into accessible forms. Ginns was curator of the Canadian Collection of Fungus Cultures for 7 years (1975–1982), and he succeeded Parmelee as Curator of the National Mycological Herbarium, which now has approximately 280,000 specimens. Since 1990, Ginns has been the Official Correspondent for Canada to the International Mycological Institute, Egham, England.

There was a 3-year interval following Ginn’s appointment before David W. Malloch, yet another student of Cain’s, joined the Mycology Section. He was the first mycologist appointed specifically to work on mushrooms and related fungi. This he did from 1971 to 1975 when he resigned to accept an appointment as Cain’s successor in Toronto (see below).

In 1975, after obtaining a Ph.D. from the University of Calgary, under the direction of Dennis Parkinson, John Bissett joined the Ottawa group. Bissett has studied many fungi, especially the Coelomycetes and those that have a symbiotic association with plants and insects. He and A. Borkent speculated on the evolutionary tendencies of one such relationship in 1988 (18), and he continues his research on fungal associations, including those that have potential for biological control of pest plants and insects.

Following Malloch’s departure, there was no agaric specialist within the Mycology Section until 1977 when Scott A. Redhead was appointed. Redhead, who had worked for his M.Sc. with Robert Bandoni, completed a Ph.D. with David Malloch in 1979 while on leave from Ottawa. He published a series of Mycological Observations, the 16th of which appeared in Mycologia in 1986. In 1989 he produced a biographical overview of the Canadian mushroom flora (140).

Saskatchewan-born Gordon A. Neish, who lived in Nova Scotia for a few years and obtained an honours degree from Acadia University in Wolfville, N.S., did his Ph.D. work with G.C. Hughes at The University of British Columbia. He joined the Mycology Section in 1978 as a research scientist and was responsible for a program on the biology and taxonomy of toxigenic fungi, with emphasis on Fusarium species (115). He served as head of the Mycology Section from 1983 to 1985 and in 1983 was appointed as the Research Branch’s first multidisciplinary research Coordinator. In 1990 he left Ottawa to become Assistant Director of the Agriculture Canada Research Station in Lethbridge, Alta.

Several Canadian plant scientists had been studying mycorhizal fungi for at least two decades before anyone in the Mycology Section began to study their taxonomy. The first mycologist to do so was Yolande Dalpé who joined the section in 1981, shortly after earning a D.Sc. in mycology at the University of Paris-Sabatier, Toulouse, France (see also Mycorhizal research).

Keith A. Seifert, from Sudbury, Ont., who earned a Ph.D. from Rijksuniversity, Utrecht, The Netherlands, in 1985, was one of the first winners of the Luella K. Weresub Award for the best mycological publication by a Canadian graduate student. Seifert joined the Ottawa group in 1990 after a 4-year period as a research scientist with Forintek Canada Corporation, Ottawa. In a remarkably short time he has become widely recognized for his studies on symbematus Hyphomycetes. He is the author of A monograph of Stilbella and some allied Hyphomycetes (147), coeditor of a book on Ceratocystis and Ophiostoma, and coauthor of two books that are in press. In his more than 30 other publications, Seifert has named several new genera and species of Hyphomycetes. In 1993 he won the Alexopolous Prize of the Mycological Society of America for remarkable contributions to mycology in the 10 years following his final postgraduate degree.

The most recent member of the mycology group is Philip M.D. Martin, a South African who has a 1964 Ph. D. from the University of California, Los Angeles. Martin did some teaching in South Africa and was involved in studies on human mycoses and mycotoxins before coming to Canada. He was
with Agriculture Canada for 9 years prior to his transfer to the mycology group in 1991, where he and Michael Corlett are developing a database of plant pests (fungi and bacteria) and their hosts.

J. David Miller joined the Chemistry and Biology Research Institute, Ottawa, in 1982, and since 1988 has been leader of a mycotoxin study program. Many of his more than 100 papers have been on fungal metabolites. He and H.L. Trenholm edited the 1993 book *Mycotoxins in Grain: Compounds Other Than Aflatoxin* (112).

**Mycology in federal laboratories outside Ottawa**

Much of the mycology conducted in federal laboratories across Canada has been applied and there have been some veritable giants whose work has had a major impact on Canadian agriculture. It is nevertheless remarkable that many of these otherwise applied scientists have contributed much to systematic mycology and to public awareness about fungi.

At the Agriculture Canada Research Station in Newfoundland, Michael C. Hampson has done some outstanding work on the potato wart disease and was the first to record on videotape the release of zoospores from resting spores of *Synchytrium endobioticum* (68). Hampson wrote an important paper on the biology, control, and history of the wart disease and its causal organism that has been accepted for publication in volume 15 of the *Canadian Journal of Plant Pathology*.

Kenneth A. Harrison (1901–1991) was a distinguished plant pathologist with an abiding love of fungi. Within a year of accepting a position as Assistant Plant Pathologist at the Kentville Experimental Farm, Nova Scotia, Harrison published on the fleshy fungi of Kentville. His publications on stipitate hydnumas, in the 1960s, established him as an authority in the Hydnaceae (70). Harrison’s son, Kenneth Jr., is an accomplished photographer-mycologist who often accompanied his father on mycological forays and photographed many of the fungi shown in his publications. Harrison’s principal co-author was Darryl W. Grund, Professor of Biology, Acadia University, Wolfville. Together they published at least a dozen papers dealing with various fungi and a book on Boletes (64).

Two Agriculture Canada employees from the same general area of Nova Scotia who made significant contributions to mycology in that province were John F.D. Hockey (1895–1980) and Carl O. Gourley. Hockey, who was Officer in Charge of the Laboratory of Plant Pathology, Kentville, from 1924 until he retired in 1960, collected fungi from the mid-1920s through the 1950s. He contributed specimens to several herbaria including the herbarium of the Nova Scotia Museum of Science, curated by Alex Wilson. Gourley, also at Kentville, retired in 1982. He will be long remembered for his very useful 200-page *An Annotated Index of the Fungi of Nova Scotia* (59) that lists 2875 taxa of fungi reported from Nova Scotia or recorded by the author up to 1982, the year before it was published.

The Agriculture Canada Research Station in Fredericton is renowned for research on potato diseases and the causal fungi. W.A. Hodgson was writing about races of *Phytophthora infestans* grown in synthetic culture media in 1958 (77), and C.H. Lawrence is known for his work on Actinomycetes (100).

There has been very little mycological research on Prince Edward Island, except for a *preliminary list of parasitic fungi in Prince Edward Island* by plant pathologist Richard R. Hurst (1895–1961) in 1957, *Races of Plasmodiophora brassicae* by George W. Annesley, published the same year (4), and Dean B. Robinson’s (1922–1961) work on variability within isolates of *Verticillium albo-atrum* (141).

Plant pathologist Colin D. McKeen, who became Pathologist-in-Charge of vegetable diseases at the Plant Pathology Laboratory, Harrow, Ont., in 1946, was well known for his work on diseases caused by *Fusarium* and *Verticillium*. Among his many accomplishments was the establishment of criteria that helped to eliminate the confusion between *V. albo-atrum* and *V. dahliae* (109). He moved to Ottawa in 1973 to become Coordinator for Phytopathology in the Research Branch, Agriculture Canada. After retiring in 1978, Dr. McKeen became the founding editor of the *Canadian Journal of Plant Pathology* and was made a Fellow of the Canadian Phytopathological Society.

Another distinguished plant pathologist at Harrow is William R. Jarvis who is recognized internationally as the authority on *Botrytis* and *Botryotina* (89). He and P.B. Topham produced one of the earliest specialized data bases in mycology (90).

One of Jarvis’ colleagues, James A. Traquair, spent 4 post-doctoral years at The University of Western Ontario and was a Research Associate with the short-lived North American Poison Mushroom Research Centre at the University of Toronto. Since then Traquair has worked at Agriculture Canada stations in Lethbridge, Harrow, and London. At Lethbridge he published on snow moulds, and at Harrow, he, Paul Horgan, and Joseph Ammirati (University of Washington) published *Poisonous Mushrooms of Canada: Including Other Inedible Fungi* (2).

Estey (46) outlined the mycological work of the first plant pathologists at the Agriculture Canada Research Station, commonly referred to as the rust lab on the campus of The University of Manitoba. Others at that station who have made more recent contributions include William L. Gordon (1901–1963), a world leader in *Fusarium* taxonomy (66); J.J. Nielsen, the authority on smut fungi of cereal crops; J.M. Martens and the late D.J. Samborsky, who contributed much to our knowledge of wheat rust fungi; and D.E. Harder, an expert on the rusts of oats (69).

At the Agriculture Canada Research Station, Saskatoon, plant pathologist J. Drew Smith was a world authority on fungal diseases of turf grasses, as well as co-author of works with Robert Shoemaker, Michael Corlett, and others on fairy rings, snow moulds, fungal taxonomy, and mycotoxicology (153). He retired in 1984. Also at Saskatoon, G.A. Petrie, a Ph.D. graduate of the University of Saskatchewan, has done some widely recognized research on *Albugo candida* (133).

There have always been scientists who could be classified as applied mycologists at the Prairie Biotechnology Institute, formerly the Prairie Research Laboratory, of the National Research Council of Canada, which is adjacent to the University of Saskatchewan. One of those was Reginald H. Haskins who became an Assistant Research Officer there in 1948. He named new genera and new species before retiring in 1981, after being Head of the Microbial Physiology and Biochemistry section for 11 years.

The first Dominion Laboratory of Plant Pathology in Alberta was established at Edmonton in 1928, under the direction of Guthrie B. Sanford (1890–1977). Melville W. Cormack became director of the second laboratory when it opened in Lethbridge in 1948. The work of Sanford, his principal co-author William C. Broadfoot who retired in 1964, and Cormack who was elected Fellow of the Royal Society of Canada and of the Agricultural Institute of Canada in 1969, the...
year he retired, has been outlined by Estey (46).

Jack B. Lebeau was one of Cormack’s colleagues at Edmonton who transferred to Lethbridge and eventually succeeded Cormack as head of the plant pathology section there. Lebeau studied a low temperature Basidionymycete as part of his Ph.D. research at Wisconsin and continued that study at Lethbridge where he also researched snow moulds and psychrophilic pathogens of grasses and legumes. He and Elmer J. Hawn studied fairy rings in Alberta and their biosynthesis of hydrogen cyanide (101). Lebeau retired at the end of 1977 and Hawn in 1980.

Plant pathologist Henry H-C. Huang, formerly at the Agriculture Canada Research Station, Morden, Manitoba, now at Lethbridge, Alberta, is well known for his work on Sclerotinia sclerotiorum (79).

**Mycology in Ontario universities**

H.S. Jackson (1883‒1951), the first Professor of Mycology in Canada, taught at the University of Toronto from 1929 until 1951 and began the excellent continuing mycological tradition at that university. Roy F. Cain’s career, which began as a student under Jackson, could almost certainly not happen today. He began as a Technical Assistant in 1938, earned three degrees, and became Head of the Department of Botany in 1959. Several of his former students are mentioned elsewhere in this paper. Cain is best known for his knowledge and publications on coprophilous fungi and for his ideas concerning fungal evolution that he outlined in his address as President of the Mycological Society of America in 1969‒1970 (26). Dr. Cain retired and was named Emeritus Professor in 1975.

Much of Cain’s mycological mission has been carried on by his successor, David Malloch, who teaches mycology at various levels and has supervised the work of 12 graduate students. In addition to taxonomic work on Ascomycetes and Basidionymycetes, he has studied the life histories of fungi having close associations with arthropods (20).

Other mycologists at the University of Toronto include John F. Morgan-Jones, who published on ascospor development in various species between 1972 and 1982, and John C. Krug, who has been Lecturer and Curator in the Department of Botany since 1982 and has written many papers on fungi in Africa, China, Europe, South America, and North America.

Michèle C. Heath, a native of Bournemouth, England and a graduate of Imperial College, University of London, joined the Toronto Department of Botany in 1972. Her achievements in plant pathology were recognized by her 1982 election to fellowship in the American Phytopathological Society and by becoming the first woman to receive Canada’s most prestigious scientific prize, the E.W.R. Steacie Memorial Fellowship. Dr. Heath has also made major contributions through her studies of the ultrastructure and function of rust fungi. These culminated in 1979 when she and Larry J. Littlefield published a beautifully illustrated book, *Ultrastructure of Rust Fungi* (104), which continues to be a basic reference in its field. In her 80 or more publications, Dr. Heath has discovered several “first examples,” including the first example of rust haustoria production away from a living plant (74).

I. Brent Heath at York University has had a career remarkably similar to that of his spouse Michèle. A native of Winchester, England, he too graduated from Imperial College. Both Michèle and Brent did postdoctoral work at the University of Georgia, and in 1979 they were awarded the Huxley Memorial Medal for achievements in research. Brent joined the faculty of York University in 1971. He has pioneered the use of three-dimensional reconstructions to analyze the biology and phylogeny of motile cells, including the flagellate rumen fungi. His multifaceted analysis of tip growth in *Saprolegnia* hyphae has provided one of the best high resolution integrated accounts of any tip-growing cell (73).

Paul Horgan’s early work at the University of Toronto’s Erindale College was on the induction of reproduction in *Achylya ambisexualis* during the 1970s (78). In the 1980s he and his colleague James Anderson started a Mushroom Research Group, which now includes Michèle Heath and others. This group, which consults with internationally known mushroom research organizations, has a major research program on the commercial mushroom, *Agaricus bisporus*, and recently published the karyotype and genetic map of the fungus (96). Horgan is editor of *The Cultivated Mushroom Research Newsletter*, published by the Centre for Plant Biotechnology, University of Toronto.

Prior to his Mushroom Research Group work, James Anderson, a doctoral graduate of the University of Vermont, wrote a thesis on *Sexuality, Speciation, and the Role of Rhizomorphs in Armillaria mellea*, which became the foundation of his international reputation for research on that species.

Also at the Erindale campus, Linda M. Kohn, an authority on the Sclerotiniaceae, recently published a very learned dissertation on the development of new characters for fungal systems (98).

The University of Guelph, which has historic connections with the University of Toronto through its Ontario Agricultural College, has had several staff members who are mycologists or applied mycologists. The most remarkable of these in recent times, and one who is still active, is Scottish-born George Barron.

Barron came to Canada after graduating from the University of Glasgow with first class honours in Botany. He earned an M.Sc. at the Ontario Agricultural College in 1955. Being interested in soil-inhabiting fungi, he went to Ohio State University to study with the late Dr. J.C. Gilman for his 1958 Ph.D. He joined the staff of the Ontario Agricultural College, now the University of Guelph, in 1958 and has become a leading Canadian expert on soil fungi, especially the life cycles of parasites and predators of microscopic life forms. In accomplishing this status he has discovered some truly remarkable fungi, 40 or more of which he described as new species. To accommodate some of these, he erected four new genera. In his wide-ranging search for fungi that parasitize nematodes and other tiny organisms, Barron and his students learned that some wood-destroying fungi, including species of *Pleurotus*, parasitize these organisms as sources of nitrogen.

Barron’s book on nematode-destroying fungi (10) confirmed him as a leader in that field, and his book on soil fungi (9) was the standard reference for many years. In recognition of these accomplishments, Barron was awarded a D.Sc. by Glasgow University in 1984, and his innovative research is continuing.

Plant pathologists at the University of Guelph occasionally publish papers that are largely mycological in content. One of the most productive of these in recent years has been Australian-born Robert Hall, who after postdoctoral work at the universities of Adelaide and California at Riverside became an Assistant Professor in the Department of Botany at Guelph in 1967. His research has dealt largely with the biology, control, and epidemiology of fungal diseases of plants, especially those caused by species of *Alternaria*, *Fusarium*, *Leptosphaeria*, *Monilinia*, *Rhynchosporium*, *Sclerotinia*, *Sor-
daria, and Verticillium. It is perhaps not surprising that he is now in the Department of Environmental Biology. In general, plant pathologists use the materials and methods of mycologists but seldom contribute to the science of mycology. Hall is an exception. He was the first to use isozymes to distinguish fungal taxa, and he was an early contributor to the idea that electrophoretic patterns of proteins could be useful in the classification of fungi and that fungitoxicants can have a role in taxonomy (67). Hall is a Fellow of the Canadian Phytopathological Society, of which he was President in 1987–1988, and he is presently Editor of the Canadian Journal of Plant Pathology.

John Sutton is another plant pathologist at Guelph who has made significant contributions to mycology. After an honours degree in agricultural botany from the University of Nottingham, he obtained a Ph.D. in plant pathology at the University of Wisconsin. In 1969 he joined the staff at Guelph where he has taught undergraduate and graduate courses in mycology. With his two dozen graduate students Sutton has published papers on mycorrhizae and a wide range of fungi that incite plant diseases, especially species of Botrytis, Fusarium, Gibberella, Peronospora, Pythium, and Trichoderma.

At Carleton University, Ottawa, naturalist William I. Illman taught mycology for 27 years, but his interests were so widespread that he did little research in that science. In 1984, he did publish his discovery of zoosporic fungal bodies in a Devonian fossil plant (86), and while working as a Visiting Scientist in the Biosystematics Research Centre, Ottawa, he published at least four papers with George P. White in which they named genera and species of Hyphomycetes (164).

At the University of Waterloo, Bryce Kendrick is the outstanding mycologist. He was a Guggenheim Fellow in 1979–1980, was awarded a D.Sc. in 1980, was elected Fellow of the Royal Society of Canada in 1981, and served as Honorary Secretary of the Academy of Science of the Royal Society for 7 years. It is impossible to do justice to Kendrick’s many accomplishments in a brief review. Suffice it to state that he, with his students and colleagues, has produced nearly 300 mycological publications, including 12 books. Three of the books are university textbooks, and one, The Fifth Kingdom (94), of which he is the sole author, originated as an expansion of Kendrick’s correspondence (Distant Education) course in mycology. This popular textbook, now in its second edition, is used in many universities in Canada, the U.S.A., South Africa, and Australia. Kendrick is regarded as a Canadian leader in numerical taxonomy and computerized information storage and retrieval (116). In this general area of expertise, he has explored and exploited the potential of computers in establishing interactive synoptic keys (93). Kendrick is widely respected for his studies on aeroaquatic, mycorrhizal, and conidial fungi. Several of his graduate students who have become teachers of mycology are mentioned below. T.R. Nag Raj, who earned his Ph.D. in 1970 under Kendrick’s tutelage, teaches mycology whenever Kendrick goes on leave and has been author or co-author of more than 100 papers in refereed journals, in addition to three books and chapters in books. His latest book Coelomycetes anamorphs with appendage-bearing conidia, (114) is a magnificent contribution to mycology.

At the University of Windsor, David A. Cotter, who is the Canadian authority on Dicystostelium discoideum, has also researched Geotrichium candidum, Schizophyllum commune, and yeasts.

Clarence James Hickman (1914–1980) had a distinguished career in mycology in England, where he was President of the British Mycological Society. He came to Canada in 1960 as Professor of Botany at The University of Western Ontario. Dr. Hickman was renowned for his knowledge of Phytophthora and Pythium and he was especially interested in, and published on, the response of zoospores to chemical, electrical, and other attractants (134).

Also at Western, plant pathologist Wilbert E. McKeen, who shared the teaching of mycology and plant pathology with Hickman for several years, had also done research on Phytophthora. McKeen received the Elizabeth Anne Wintecorby Award for distinguished research at the University of Toronto and had several years of research experience with Agriculture Canada before going to Western. From a mycological standpoint, he is noteworthy not only because he and R.C. Zimmer named a new species of Mucorphaerella (110) but also because he identified several races of Phytophthora fragariae, published on the flagellation, movement, and encystment of zoospores, and on the powdery mildews. Dr. McKeen, who is now retired, was President of the Canadian Phytopathological Society in 1979–1980.

M.S. Manocha went to Brock University, St. Catharines, in 1966 and is now Chairman, Biological Sciences. He has worked on host-parasite relations of mycoparasites and used immunofluorescence to study syzygomycteous fungi and cell surface features of haustorial mycoparasites.

Harold M. Good, a Professor of Biology at Queen’s University, served a term as President, Canadian Association of University Teachers, while maintaining active interests in fungal succession in maple tree decay, Cladosporium blight of sweet peas, factors affecting the germination of Fomes igniarius, and the effects of drinking on the viability of the spores of Botrytis cinerea, Cercospora musae, and Monilinia fructicola.

Quebec universities

Much of the early teaching and research in mycology at McGill University was done by botanists. For example, Stuart M. Pady, Associate Professor of Botany, was an aeromycologist who studied fungi in arctic air from 1947 to 1955 and collaborated with L. Kapica in similar studies over the Atlantic Ocean (124).

Charles M. Wilson (1916–1989) went to McGill as an Assistant Professor of Botany in 1954 and retired as Professor of Botany in 1982. He was noted for his research on the cellular and plasmoidal slime moulds. Wilson and his doctoral student, Ian K. Ross (now at the University of California in Riverside), researched Dicystostelium and published on meiosis in the Myxomycetes (167). Their work was important in popularizing the slime moulds as research organisms. Wilson’s last graduate student, Christopher J. Lucarotti, taught introductory and intermediate mycology at Macdonald College, worked as a postdoctoral research mycologist at the University of California and Mount Saint Vincent University, Halifax, before becoming a research scientist in the Canadian Forest Service, Fredericton, New Brunswick. His major mycological activity since graduating from McGill has been research on species of Coelomycetes and other fungi that parasitize insects.

The work of W.P. Fraser, B.T. Dickson, J.G. Coulson, Dorothy Newton, Harold Brody, I.H. Crowell, and E.O. Callen, each of whom taught mycology at Macdonald College, has been reviewed by Estey (46).

Dr. Callen was more of a botanist than mycologist and gladly gave the responsibility of teaching mycology to Ralph H.
Estey, who joined the academic staff of Macdonald College in 1957 after teaching mycology and plant pathology for a year in the University of Connecticut. Estey taught mycology at three levels plus the history of plant pathology, became chairman of the Department of Plant Pathology, and supervised the research of 33 graduate students. Two of those students, doctoral candidates T.H.A. Olthof and S.S. Tzean, were noteworthy. Olthof, from The Netherlands, received a Ph.D. in 1970 for some pioneering research on nematophagous fungi (47). Tzean, from Taiwan, made significant advances in the study of nematode-destroying fungi and nematode-capturing methods. After being awarded a Ph.D., Tzean continued studies of mycoparasitism and discovered new species (159).

Along the way, Estey earned a B.Ed. degree from the University of New Brunswick in 1960, and a D.I.C. from Imperial College, London, England, in 1965. He became a Fellow of the Linnean Society of London, a Fellow and one term President of the Canadian Phytopathological Society, then President for 1 year, and Honorary Member of the Quebec Society for the Protection of Plants. Estey retired and was awarded Emeritus Professor status in 1982. Since then he has become known among the mycologists in Ottawa and Montreal for advocating the use of “Mycarium” as a replacement for “Mycological Herbarium,” because, he argues, fungi are no longer considered to be plants and herbarium is therefore not appropriate.

Mycology is presently taught at Macdonald College by Suha Jabaji-Hare, who earned her Ph.D. in 1984 with Bryce Kendrick.

At Concordia University, Montreal, microbial ecologist Paul Widden, whose Ph.D. research was supervised by Dennis Parkinson at the University of Calgary, has published, with Ivan O’Halloran of McGill and their former student Dr. Margaret Cooke, several papers on mycorrhizae of maple trees (35). Widden and J. Bissett built an apparatus for removing fungal spores from soil and described a new species of Aspergillus (19).

Laval University in Quebec has had several distinguished mycologists on its staff, none more so than René Pomerleau, who was the dean of mycologists in eastern Canada for many years, as well as the Canadian most widely known among North American amateur mycologists. Born in 1904, Pomerleau was active in mycology from about 1926 until a few weeks before he died on 11 October 1993. In addition to a D.Sc. from the University of Montreal, Dr. Pomerleau had honorary doctorates from Sir George Williams University (now Concordia University) and from the University of Toronto, plus prizes and awards too numerous to list here. Pomerleau was well known to amateur mycologists because of his popular illustrated books on mushrooms and other fleshly fungi. The first of these, Mushrooms of Eastern Canada and the United States (137), was published in English and in French in 1951 and was an immediate success, partly because it contained reproductions of the beautiful paintings of mushrooms by Canadian artist H.A.C. Jackson but mostly because of its clear instructions for identifying a number of edible and poisonous species. The French version was republished in 1977, and his 605-page Flore des champignons du Québec, with descriptions of 1400 species, was published in 1980 (138). An 88-page supplement, with new species and corrections, appeared in 1984. Although Pomerleau was a venerable mycologist and taught mycology at Laval University from 1940 until 1965, he was also a pioneer forest pathologist and established an enviable reputation as such over a period of some 40 years. It was he who first discovered Dutch elm disease in Canada and consequently several of his mycological publications deal with that disease and those of other forest trees. They are among the 200 or more scientific papers that he published before and after retiring in April 1970.

J. André Fortin, F.R.S.C., formerly at Laval University, credits Pomerleau with having stimulated his interest in the fungi. Fortin became founding director of the Centre for Research in Forest Biology at Laval and the Canadian leader in mycorrhizal research. (See also Mycorrhizal research.) In 1990, he became the founding director of the Institut de recherche en biologie végétale de Montréal, which is a partnership between the Université de Montréal and the Botanical Gardens of Montreal.

Hungarian-born Gyorgy-Miklos Olah, who teaches mycology at two levels plus a course on the physiology of fungi at Laval University, has written three books and published papers in three languages in Europe and in North and South America. The book that roused the interest of many amateur and professional mycologists, especially in eastern Canada, dealt with the identity and culture of the oyster mushroom. It is now in a second edition (121).

Atlantic Canada universities

A number of people have collected fungi in Newfoundland but little professional work in mycology was carried on there until Richard A. Nolan, first as a postdoctoral fellow at Memorial University, St. John’s, then as a faculty member, began studies on aquatic Hyphomycetes and nematophagous fungi. Recently he has been researching the nutrition, biochemistry, and mass-fermentation production of Entomophaga aulicea for biocontrol of forest pest insects (119).

At Acadia University, Wolfville, N.S., Darryl W. Grund is representative of academics in relatively small institutions who teach several subjects in addition to mycology and have little time for research. In spite of these restrictions and the fact that he is curator of the Acadia mycological collection of about 16,500 specimens, Grund has published extensively on fungi in Nova Scotia, especially with Kenneth Harrison. In 1979, he and Carolyn Bird published a comprehensive paper on Nova Scotian species of Hygrophorus (15). Grund also worked with the late Daniel E. Stuntz of the University of Washington and published a series of papers on Nova Scotian Inocybes, the eighth of which appeared in 1984 (65).

At the University of New Brunswick, Fredericton, Norman Whitney’s many mycological studies, in addition to forest pathology, include marine fungi around Prince Edward Island and the discovery of a new species of Didymosphaeria (155). (See also Mycology and forest pathologists.)

Swiss-born Felix J. Bärlocher, a professor in the Department of Biology, Mount Allison University in Sackville, N.B., worked with Bryce Kendrick to translate Müller and Loeffler’s Mycology from German into English, and in 1992 he edited The Ecology of Aquatic Hyphomycetes (7), a book that reflects his own major research interest.

Prairie universities

At The University of Manitoba, plant pathologist Claude C. Bernier and his graduate students in the Department of Plant Science studied pathogenic variability in several species, diversity in Rhizoctonia solani, and with R.L. Conner, race identification in Uromyces viciae-fabae (32).
James Reid, who was a forestry research officer for 10 years before being appointed Professor in the Department of Botany in 1966, has contributed to the taxonomy of the Diaporthales, the Ophiostomatales, and some tree rusts. He, Georg Hausner, and Gien Klissen, from the Department of Microbiology, recently published on species of Ceratocystis (72). Reid also worked with James A. Dowsett who taught introductory mycology and was for several years the leading Manitoba researcher on Dactylaria, Dactylella, and related fungi (44).

Tom Booth, who joined the Department of Botany in the mid-1970s, has continued to study fungi in marine ecosystems in spite of a location several hundred kilometres from the nearest salt water. His work on lignicolous and zoosporic fungi in Hudson Bay (22) extends studies begun as a Ph.D. student at The University of British Columbia under the supervision of Gilbert C. Hughes, the Canadian authority on fungi in marine habitats.

Hans E. Gruen, a native of Berlin, Germany, with degrees from Brooklyn College and Harvard, joined the University of Saskatchewan, Department of Biology in 1964. When he retired in 1993 he left a legacy in students from the two mycology courses that he taught for nearly 30 years and several publications that left us with a better understanding of internal growth regulation in fruit bodies of Agaricaceae during their expansion phase (63).

Plant pathologist Robin A.A. Morrell in the same department has published occasional mycological papers. For example, he wrote on two species of Oidiodendron in 1968, on soil microfungi associated with aspen in 1974, and is one of the authors who renamed Ascochyta fabae (58).

Arthur W. Henry (1906—1989) was a highly respected plant pathologist who worked at the University of Alberta for more than 50 years, including at least 20 years after his official retirement in 1962. He was among the pioneers in a study of spores in the upper air (154) while a student in Minnesota. In Alberta, most of his mycologically oriented work pertained to Fusarium culmorum, Ophiobolus graminis, Polyspora lini, and Trichoderma viridi, and he supervised 30 graduate students. The province of Alberta gave him its Award for Achievement in Science in 1976.

Lorene L. Kennedy joined the Department of Botany in 1958, soon after obtaining her Ph.D. from Iowa State University. Her early work on the Dacrymycetaeae, for which she became well known, was an extension of her doctoral thesis. In the 1970s she turned her attention to basidiocarp development and basidiospore germination in Polyporus and Fomes (95).

Since 1985, Randolph S. Currah, in the Department of Botany, has followed Pirozynski's broad footsteps. His research interests range from fossil fungi to the taxonomy, ecology, and development of mycorrhizal fungi. In 1987 he named a new species from orchid roots (39).

William P. Skoropad (1918—1993) joined the University of Alberta in 1959 after 4 years with the Agriculture Canada Laboratory of Plant Pathology, Edmonton. He and A.H.H. Grinchenko described a new spore form in Rhynchosporium secalis in 1957 (151). Hertha Grinchenko, who was born in Russia in 1900 and came to Canada in 1948, is specifically mentioned because she represents the many technicians who seldom receive the recognition they so rightly deserve. Her beautiful pen sketches and camera lucida drawings grace the pages of several plant and forest pathology papers from the Edmonton and Calgary laboratories, for example, the description of a new species of Ceratocystis by Robinson and Grinchenko (142). Skoropad, with J.P. Tewari and others, especially A. Tsuneda, published on many topics including mycorrhizal fungi, phyloplane fungi, the ultrastructure of spores, and the mode of parasitism by Nectria inventa, to mention only a few.

E. Silver Keeping (Dowding) came to the Provincial Laboratory of Public Health, University of Alberta in 1933 and established the first diagnostic service for human fungus diseases in the British Commonwealth. She amassed a collection of fungi that was developed further by Alexander Bakerspigel, who experimented with the use of soil as a storage medium for fungi (5), and by J.W. Cærnicl. Carmichael, who had made a taxonomic study of the genus Geotrichum for his Ph.D. thesis at Harvard in 1954, published several papers on fungi, including one on aleurosporic hyphomycetes (28), before he retired in 1983.

More recently, Lynne Sigler, the present curator of what is now the University of Alberta Microfusus Collection and Herbarium, has developed the collection of living microfungi into the second largest fungus service collection in Canada. Sigler, who is a member of the Department of Medical Microbiology and Infectious Diseases, is co-author, with Carmichael, Kendrick, and I.L. Conners, of the book Genera of Hyphomycetes (29).

Dennis Parkinson, F.R.S.C., who was a Ph.D. student of C.G.C. Chesters at the University of Nottingham, England, has been at The University of Calgary since 1967. During a 35-year career in the universities of Liverpool, Waterloo, and Calgary, Parkinson has supervised the research of more than 40 graduate students and authored more than 150 publications. His research in Canada has been focused on the nature, activity, and distribution of microorganisms in natural soils and in the root region of crop plants and tree species. (See also Soil fungi.)

**British Columbia universities**

The first significant amount of teaching and research in mycology at The University of British Columbia (U.B.C.) was done by Frank Dickson (1891—1969), originally from Leicester-shire, England. Dickson retired in 1956 and the teaching of mycology was taken over by Robert J. Bandoni, who joined the Department of Botany in 1958 after training in Nevada and Iowa. Bandoni's research was always broadly based, but his most significant contributions have been in systematics and the general biology of heterobasidiomycetes. He and others, especially F. Oberwinkler, have named new orders, families, genera, and species of fungi from terrestrial and aquatic habitats. He continues as Curator of the Mycological Herbarium of the Department of Botany and was granted Emeritus Professor status by the University when he retired in 1989. In recognition of his many contributions to mycology and biology in general, he was awarded the George Lawson Medal of the Canadian Botanical Association in 1990. His successor, Mary Berbee, continues the catholic tradition of U.B.C. mycology with her studies of the evolution of morphology, using the methods of molecular biology.

Dr. Berbee, Dr. Bandoni, and 16 others have cooperated in the development at U.B.C. of one of the most comprehensive graduate programs in mycology that is available anywhere.

One of Bandoni's colleagues at U.B.C. was the plant physiologist Michael Shaw, who published a number of mycological papers. Shaw, whose career included successful terms as Dean of Agricultural Sciences and Vice-president (Academic),
was fortunate in having Rosalinda (Boasson) Verbeek as one of his assistants. Together they achieved successful axenic culture of several generations of *Melampsora lini*, the flax rust fungus (21).

Gilbert C. Hughes, of U.B.C., was a Canadian pioneer in research on marine fungi and has become an acknowledged leader in that field since he studied lignicolous species from Newfoundland (80) nearly 18 years before they were studied elsewhere on the east coast of Canada (155).

John W. Paden (1933–1990) taught forest pathology and mycology in the Biology Department at the University of Victoria for almost 25 years. Paden, a native of California, graduated from the University of California and received graduate degrees from the University of Idaho. In Canada he published several papers on Hypomyces, including a new genus (123), and was doing research for another paper when tragedy ended the life of this talented mycologist.

**Mycology and forest pathologists**

Estey’s book (46) includes an essay entitled *Early Forest Pathology in Canada*, in which there is a commentary on all Canadian forest pathologists prior to 1950. It includes the work of William P. Fraser (1867–1943), the teaching of mycology and forest pathology by Joseph Horace Faul1 (1870–1961), and the work of his graduate students Hugh P. Bell (1889–1957), Lilian M. Hunter (1892–1970), Ezra H. Moss (1892–1963), James H. White (1875–1957), Clara W. Fritz (1889–1974), and Irene Mounce (1894–1987), all of whom became widely known for their studies on the fungi that cause tree diseases or the deterioration of wood.

More recent forest pathologists who have contributed to mycology in Canada include the three Whitney brothers, Norman, Roy, and Stuart. They are unique in that they have all been plant (including forest) pathologists who produced mycologically oriented publications. Their uniqueness was recognized when the Canadian Phytopathological Society and the Canadian Forestry Service jointly presented them with a special certificate of achievement in 1988. The senior brother, Norman J. Whitney, worked as a plant pathologist at the Agriculture Canada Research Station, Harrow, Ont., for 9 years before resigning in 1961 to study theology at McGill University and be ordained a minister in the United Church of Canada. During his ministry in churches near Fredericton, N.B., Dr. Whitney began teaching mycology in 1965 as a part-time Lecturer in the Department of Biology, University of New Brunswick. In 1973 he became a full-time Associate Professor of Biology and Counselor in Student Services and was promoted to Professor in 1981. He officially retired in 1991 but continues to work. He and J.D. Miller, a doctoral candidate, published an elegant series of papers on fungi in the Bay of Fundy, the sixth of which, co-authored with J.A. Findley and Y.E. Moharir, appeared in 1984 (111). He also participated with L.A. Calboun, Findlay, and Miller in a study of fungal metabolites toxic to the spruce budworm in 1992 (27).

Roy Whitney, the middle brother, has been more of a forest pathologist than either of his siblings. He began with a degree in forestry from The University of British Columbia in 1951, the year in which he was employed in the Forest Research Laboratory, Saskatoon, Saskatchewan. He took leave periods to earn a master of forestry degree from Yale University in 1954 and a Ph.D. from Queen’s University in 1956. He was a forest pathologist at Winnipeg from 1966 to 1970, and from 1971 until he retired in October 1988 at the Forest Research Laboratory in Sault Ste. Marie, Ontario. Most of his mycological papers, and many co-authored with Wendy P. Bohaychuk, deal with *Pseudopeziza fuscum,* mycorrhizae of forest trees (166). Dr. Bohaychuk worked in the Forest Pathology Laboratory from 1967 to 1970 while earning her masters degree at the University of Manitoba. Her Ph.D. is in education.

Roy Whitney’s colleagues in Sault Ste. Marie included J.Y. Park and B. Moore, who jointly described a new mycorrhizal fungus of American basswood in 1971 (126), and M.T. Dumas who was studying biological species of *Armillaria* in 1988 (45). Another colleague was Charles E. Dorworth, who produced an Environment Canada Forestry Service leaflet *Mushrooms of Ontario* in 1979 and researched *Gremmeniella abietina* for nearly 12 years. He and J. Krywiencyzk described methods of making comparisons among isolates of the fungus to reveal races within the species (43).

In the Insect Pathology Research Institute (Forest Pest Management Institute) that is in the same building complex at Sault Ste. Marie, Donald M. MacLeod researched entomogenous fungi for more than 20 years (105) after his first paper on *Beauveria* in 1954.

H. Stuart Whitney has had a major interest in the taxonomy and heterokaryons of *Rhizoctonia* and in insect–fungus–tree relationships. His work at the Forestry Canada Pacific Forest Research Centre, Victoria, B.C., included collaboration with R.J. Bandoni and F. Oberwinkler to describe a new genus and species in the Basidiomycotina (165).

Several others at the Pacific Forest Research Centre have made important contributions to mycology in Canada. They include Alvin Funk, Wolf Ziller, Richard Hunt, Duncan Morrison, and Jack Sutherland.

Alvin Funk, a native of Saskatchewan with a Ph.D. in mycology and plant pathology from the University of Toronto, was a mycologist in the forest pathology laboratory from 1958 to 1990. During that time he named about 50 species of fungi, and several others were named with the cooperation of one or more co-authors. For example, J.A. Baranyay and Funk named *Helotium resinicum* in 1969, and Stuart Whitney and Funk named *Pezizella chapmanti* in 1977. Funk also completed the life-cycle description of several species in which only part of the spore states had been previously discovered. Much of his work culminated in the publication of the handbooks *Parasitic microfungi of western trees* (49) in 1981 and *Foliar fungi of western trees* (50) in 1985. The latter publication makes several references to the work of Wolf Ziller, after whom Funk named *Stigmina zilleri* in 1986 (51).

Wolf G. Ziller migrated to Canada from Germany in 1930 when he was 19 years old, graduated from The University of British Columbia in 1949, and joined the Forest Pathology Laboratory as a Regional Mycologist. He took leaves of absence to attend the University of Toronto for M.A. and Ph.D. degrees, the theses for which dealt with tree rusts in British Columbia. His 272-page book, *The Tree Rusts of Western Canada* (168), published in 1974, presents a review and summary of information about the 70 tree rusts that occur in Canada west of 95° longitude. Dr. Ziller retired as a Disease Survey Officer in 1973.

Richard S. Hunt has been at the Victoria laboratory since 1973. For several years he was a leader in research on the white pine blister rust on the west coast of Canada and has also published on *Lophodermella concorla*, *Gymnosporangium fuscum*, *Parvacoccum pini*, *Leptomelanconium pinicola* (84), and various others.
Duncan J. Morrison, a native of Vancouver, began working at the Pacific Forest Research Centre as a summer student in 1965. He was appointed research officer the following year, and during study leaves he earned an M.Sc. in 1968 and a Ph.D. in 1972, the latter from the University of Cambridge, England. Dr. Morrison has worked and published on various fungi involved in forest tree diseases, including *Fomes annosus* and *Verticicladia waggeri* but with emphasis on species of *Armillaria* (113).

Forest pathologist Jack R. Sutherland, is as much a nematologist as mycologist. While stationed in Quebec, he and J.A. Fortin published on the effect of nematodes on mycorrhizal fungi, and since moving to Victoria, he has studied fungi in stored conifer seeds and their role in seedling diseases (156).

Harry Zalasky published three papers in the *Canadian Journal of Botany* in 1964, reporting on work done from the Forest Pathology Laboratory, Saskatoon. He named a new genus and new species in that journal in 1968 and wrote on the perfect state of *Diplodia tumefaciens* in 1974, when he was stationed at the Northern Forest Research Centre, Edmonton, Alta. Zalasky was junior author with A. Funk in describing the new species *Rhytidiella baranyayi* (52), named in honour of the late J.A. Baranyay who had listed the fungi collected during forest disease surveys on northern Alberta and the district of Mackenzie, Northwest Territories in 1968 (6).

Brian C. Sutton moved to the short-lived Forest Pathology Laboratory in Winnipeg as a Research Scientist in 1965. He had worked at the CMI, Kew, England, and was exceptionally well qualified to act as a resident mycologist and to serve as an honorary professor at the University of Manitoba. Although he returned to the CMI in 1969, Sutton authored more than 25 papers based on work done in western Canada, including his 146-page *Hyphomycetes from Manitoba and Saskatchewan, Canada*, published in 1973 as Mycological Paper (CMI) No. 132.

Yasuyuki Hiratsuka has become widely known for his research on the biology, pathology, and taxonomy of the tree rusts, carried out at the Northern Forest Research Centre, Edmonton, Alta. Hiratsuka is a third generation plant pathologist — mycologist whose father was Director of the Tottori Mycological Institute in Japan. He and J.M. Powell published a monographic work entitled *Pine Stem Ruts of Canada* in 1976 (76), and he was co-author with G.B. Cummins of the book *Illustrated Genera of the Rust Fungi* in 1983 (38). Dr. Hiratsuka has also researched several other tree-disease fungi, and he is compiling a monograph of worldwide pine stem rusts.

John M. Powell, also at the Northern Forest Research Centre, is a naturalist who won the Lorain Goulden Memorial Award of the Edmonton Natural History Society and who has published several papers on forest tree rusts, especially on *Cronartium comandrae*, the fungus that was the subject of his Ph.D. thesis from The University of British Columbia.

At the Forest Entomology and Pathology Laboratory, Calgary, R.J. Bourchier found and named two new imperfect fungi from the heartwood of living lodgepole pine (23). This was an extension of his Ph.D. thesis of 1960 at the New York State University, College of Forestry, Syracuse, N.Y.

Several mycology papers have been produced from the Forest Research Laboratory in Maple, Ont. that contributed to mycology in Canada. For example, H.D. Griffin’s paper on *Ceratocystis* in 1968 (61) included a key to 60 species and descriptions of the 32 species found in Ontario.

Arms were added to the Laurentian Forest Research Centre, Ste-Foy, Que., in 1968 and a *Lophomerum* as a new genus of the Hypodermataceae (122). Edgar Smerlis researched the pathogenicity of a number of fungi and the taxonomy of one or more new species (152). His colleague Guilemmond B. Oueltte, a graduate of Monton University, Moncton, N.B., whose Ph.D. was from Cornell University in 1960, has published extensively on *Ophiostoma ulmi* and a wide range of other fungi associated with tree diseases. As a sole or co-author, he has proposed 20 new species or recombinants. In 1966 he and Laszlo P. Magasi of the Maritimes Forest Research Centre, Fredericton, N.B., named *Lophomerum* as a new genus of the Hypodermataceae (122).

**Fungal genetics in Canada**

The study of fungal genetics began in the late 1920s and it was the work of Buller and his doctoral students Dorothy Newton, William F. Hanna, and John H. Craigie at the University of Manitoba who set the stage for the development of that emerging science in Canada. Dorothy Newton made some pioneering studies on the sexuality of species of *Coprinus*; William F. Hanna’s thesis consisted of four published papers on sex and the inheritance of spore size in mushrooms; and John H. Craigie is remembered mostly for his discovery of the function of the pycnia of the rust fungi, which made it possible for Margaret Newton and Thorvaldur Johnson to demonstrate that inheritance in the rust fungi follows Mendelian laws. The early work in fungal genetics by these and others whose contributions were made before 1950 has been outlined by Estey (46).

In the 1950s almost everyone who worked with fungi dabbed a bit in fungal genetics even if it was little more than to check on mating systems and the compatibility of strains. For this reason, only a few of the major contributors to fungal genetics in Canada are mentioned here. The greatest stimulus for plant pathologists to study fungal genetics came from the gene-for-gene theory proposed by H.H. Flor (U.S.A.) in 1953 (48) to explain certain results he had obtained in studies of flax and the flax rust fungus. He concluded that for each gene determining resistance in flax there is a specific and related gene determining virulence in the rust.

The outstanding proponent and interpreter of that theory in Canada was geneticist Clayton O. Person (1922–1990), who rigorously tested the hypothesis and considered it to be valid (131, 132). Moreover, Person extended the hypothesis beyond the flax rust system to include all systems of parasitism and presented a method of analysis that would reveal the existence of gene-for-gene relationships in parasitic systems that are not accessible for study using the conventional, or classical, genetic approach (149).

Person’s early work was done at the University of Alberta where he earned a Ph.D. in cytogenetics. He worked at the Agriculture Canada Research Station in Winnipeg for 5 years and then in the Department of Genetics at The University of Alberta from 1961 to 1966. After that, and until he retired, Person was Professor of Botany at the University of British Columbia. He was elected Fellow of the Royal Society of Canada in 1971, Fellow of the American Phytopathological Society in 1981, and was awarded the Order of Canada in 1987, to mention only a few of the honours he received for his work.

One of Person’s former doctoral students, Jane Robb, is presently at the University of Guelph, where among other work, she is studying the genetic relationship between *Verticillium* and tomato plants (102).

Fungal genetics played a vital role in the development of
high quality, disease-resistant crops all across Canada but nowhere more so than at the Agriculture Canada Research Station in Winnipeg. That is where Clayton Person worked and developed some of his concepts in fungal genetics between 1956 and 1961, where Gordon J. Green (1920–1982) was widely known for studies on physiologic races of *Puccinia graminis* (60), and where Jens J. Nielsen, a graduate of the University of Goettingen, Germany, contributed to research on species and races of cereal smut fungi and techniques for their study (117). There also the gene-for-gene theory of host–parasite relationship was tested by Martins et al. (107), and P.L. Thomas researched the genetics of smut fungi (157).

The discovery by Pontecorvo of a system of somatic recombinations of fungal nuclei, which he called the parasexual cycle (139), prompted a search for this genetic phenomenon in various fungi. In Canada, one of the most noteworthy researchers was Etta Kafer in the Genetics Department of McGill University. Kafer earned her Ph.D. from the University of Zurich in 1953, then worked as a Nuffield Research Fellow at the University of Glasgow and as a Carnegie Research Fellow at both the Carnegie Institute and Cold Spring Harbor before moving to McGill in 1958. She is well known for her pioneering work on mitotic recombination and chromosome assortment in *Aspergillus* (91). The clarity with which she explained the genetics of parasexual systems in fungi formed the basis for discussions of the possibility of somatic cell genetics in other organisms. Dr. Kafer received the 1987 Genetics Society of Canada Award of Excellence “for her outstanding contribution to the genetics of filamentous fungi” (54) and to the flowering of molecular genetics in *Aspergillus* and *Neurospora*.

Following closely on the heels of Dr. Kafer’s early work with *Aspergillus*, George Barron and Blair MacNeill, at Guelph, outlined a simplified procedure for demonstrating the parasexual cycle in that fungus (11).

By the 1960s much had been learned about the genetics of the rust fungi, but D.B.O. Savile was the first to prove genetic recombination in a rust fungus without pycnia (145), and he, with J. Parmelee, presented the first convincing case of parasexual recombination in a rust fungus (146).

At the London Research Centre of Agriculture Canada, Edmund W.B. Ward surprised many mycologists with his assertion that conventional mitosis took place in Basidiomycetes (161). This was at a time when the predominant view was that vegetative nuclear division was amitotic. Ward, who had more than 100 publications to his credit before retiring in 1993, received the Award for Outstanding Research of the Canadian Phytopathological Society.

The exemplary work with *Agaricus bisporus* by Paul Horgan, James Anderson, and their colleagues at Erindale College is based almost entirely on their acquired knowledge of the genetics of that fungus (96, 97). They have also been using molecular genetic approaches to understand the population dynamics of *Ophiostoma ulmi*.

Sexual reproduction in fungi is affected and controlled by many factors, not the least of which is nutrition. Reginald H. Haskins and colleagues at the Prairie Regional Laboratory of the National Research Council discovered that certain sterols are required for the formation of oospores by *Pythium* species (71). With that information available to them, others soon learned how to stimulate sexual reproduction of fungi in artificial media.

Genetic engineering is a science in which Canada has an acknowledged world leader. Michael Smith of The University of British Columbia was awarded a Nobel Prize in 1993 for his phenomenal research on mutigenesis in yeasts (1, 103). He used site-directed mutagenesis in such a way that specific mutations, tailored in vitro, could then be introduced into the genome of his experimental organisms. Smith’s innovation enables researchers to reprogram a cell’s DNA and thus change the structure of the proteins the DNA encodes.

**Soil fungi**

Over the years, many Canadian mycologists have studied soil-inhabiting fungi, the pioneer being Michael I. Timonin (1900–1991) who studied the microfungi in profiles of virgin soils in Manitoba in 1935 (158). Timonin was one of the most versatile of mycologist-naturalists and the story of his many accomplishments is yet to be written.

Because of the ease with which it could be done, the isolation of fungi from soil became very popular, not only as a sure-fire project for students of mycology but also as a project for anyone searching for unrecorded fungi or for a new isolation device or method. However, when thinking of mycologists who are presently active in Canada, Dennis Parkinson and George Barron are outstanding in this regard.

Parkinson, as an editor with John Waid, stimulated a wave of interest in soil fungi with the publication of *The Ecology of Soil Fungi* (127), which is the record of an international symposium held in Liverpool, England, in 1958. He then reinforced that interest with *Methods for Studying the Ecology of Soil Microorganisms* (128). Most of Parkinson’s 150 or more publications deal with various aspects of soil fungi.

Barron received almost immediate recognition as a leader in the study of soil fungi through his *The Genera of Hyphomycetes from Soil* (9). That leadership has been consolidated and reinforced by his many publications about the fascinating fungi that he and his students found and described.

Bryce Kendrick, who participated in the Liverpool symposium in 1958, is another Canadian mycologist who ranks high among those who work with soil fungi. This is evident from his several papers on the breakdown of litter and his paper on soil fungi in a copper swamp (92).

Pritam Singh made a comprehensive study of fungi in forest soils of Newfoundland (150) while at the Newfoundland Forest Research Centre, St. John’s.

In a very real sense, Estey, Oltbof, Tzean (47, 159), and others (Barron and Kendrick are in this group) who searched for nematophagous fungi were dealing with soil fungi.

**Mycorrhizal research**

Since the mid-1960s mycorrhizal research in Canada has been largely centered around Laval University where André Fortin has been the dominant figure. Thirty-three of his graduate students wrote theses based on mycorrhizal research. Fortin has published more papers on mycorrhizae than any three others in Canada, and he organized the 5th North American Conference on Mycorrhizae, at Laval, in 1981.

Dr. Fortin’s former student, Valentin Furlan, who earned his D.Sc. in 1976, has continued research in Fortin’s laboratory since 1977 and been a co-author with him of many articles dealing with mycorrhizae. Their flotation-bubbling system for collecting spores of Endogonaceae (53) stimulated many others to try variations of their method.

Yves Piché, another of Fortin’s distinguished students and
now an Associate Professor at Laval University, made a major contribution when in 1992 he, Sylvie Chabot, and G. Bécard described the entire life cycle of a mycorrhizal fungus as they followed it in a simple monoxenic culture system (30).

One of Piché’s four postdoctoral fellows was Leonard J. Hutchison who had studied systematics of mycorrhizae in axenic culture for his Ph.D. under Malloch’s supervision at the University of Toronto. One of Hutchison’s major accomplishments to date has been the description and identification of cultures of the ectomyorrhizal fungi of North America (85), and he has at least 15 other papers to his credit. Hutchison is now a colleague of David Malloch at the University of Toronto, and Malloch’s major research interest for some time has been the ecology and evolution of mycorrhizal associations (106).

Linda Kohn, at the Erindale campus of the University of Toronto, is another one of the increasing number of Canadians who have worked on the mycorrhizal status of plants. She and Elida Stasovski published on the mycorrhizae of plants in the Canadian High Arctic (99).

Shannon M. Berch has an academic pedigree that is an example of the diversity required in modern mycorrhizal research. She studied endomycorrhizae of ferns and fern allies for an M.Sc. with Kendrick at Waterloo (13), moved to Laval to learn how to culture a mycorrhizal fungus on mycological media while studying for her Ph.D. under Fortin, and then did postdoctoral work with James Trappe at the USDA laboratory in Corvallis, Oreg. Dr. Berch became a member of the Department of Soil Science, The University of British Columbia, and made important contributions regarding the mycorrhizal status of plants in B.C. (12). She is currently with the B.C. Ministry of Forests.

Hugues B. Massicotte in the Faculty of Forestry, U.B.C., was known for his mycorrhizal research before joining the staff there in 1992. In 1988 he won the Luella K. Weresub Award for the best mycology paper published by a Canadian student. Since earning a Ph.D. at Guelph, where he worked with R.L. Peterson and with whom he has published 20 papers on mycorrhizae, Massicotte has published several papers with J.M. Trappe and other mycorrhizal specialists (120).

At the University of Guelph, R.L. Peterson has produced some outstanding micrographs of mycorrhizal fungi while studying the interactions between root pathogens and ectomycorrhizae. He has also studied the effect of phosphorus on the morphology of VA mycorrhizal fungi and the interactions between alfalfa nodulation genotypes and species of Glomus (25), to mention only a few of his wide-ranging studies.

At McGill University in the late 1970s, R.H. Estey and his graduate student Joan Herskowitz discovered five species of Endogonaceae in Quebec soils (75) while he and E.O. Salawu studied the relationship of fungiforous nematodes, mycorrhizae, and the growth of soybeans (143).

Suha Jabaji-Hare, presently at McGill University, is another mycologist who did mycorrhizal research with Kendrick at Waterloo (88). She has also published on mycorrhizal fungi with J.A. Fortin and Y. Piché, in addition to papers of which she has been the sole author (87).

At the Centre for Land and Biological Resource Research of Agriculture Canada, Ottawa, Yolande Délpé is devoting almost full time to mycorrhizal research and has searched for mycorrhizae in the Anapolis Valley of Nova Scotia, the Okanagan Valley in British Columbia, and many places in between. Working alone and with others, Dr. Délpé has discovered several new species of mycorrhizal fungi (40), collaborated with Pirozynski in a study of the geological history of the Glomaceae (135), and studied the taxonomic relevance of the fatty acids of certain mycorrhizae (41). She is the Canadian specialist in mycorrhizal taxonomy.

Conclusion

Mycology in Canada is not basically different from mycology in other countries. However, the fact that much of Canada is covered with snow and ice for several months each year does impose certain restrictions on mycological activity. One could argue that the long winters tend to make Canadians more prolific writers. Evidence for this lies in the fact that on a per capita basis, there have been more papers from Canada published in Mycologia over the past two decades than from any other country, including the U.S.A.

Canada has welcomed mycologists from many countries, to such an extent that three-quarters or more of the top-ranking mycologists now working in this country came here as immigrants. They have been in the forefront of those who helped to make Canada a "major power" in the realm of mycology.


