THE CANADIAN BOTANICAL ASSOCIATION

BULLETIN

L'ASSOCIATION BOTANIQUE DU CANADA

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GRADUATE STUDIES IN BOTANY

This issue of the Bulletin is devoted to a review of graduate studies and research in botany in Canadian Universities. At a time of increasing concern over employment for graduate students and increasing financial stringencies in the universities it is appropriate that we should be planning for the future as well as looking at the present and reviewing the past. In recent months there have been several important documents bearing on graduate education in botany in Canada. Two of these are reviewed below and these reviews are followed by an account, compiled by Dr. Kendrick, of the graduate schools in botany in this country, their personel and areas of research and specialization.

The Botany Department, University of Toronto, has undertaken a nation-wide survey to estimate how many graduate students will seek employment in the foreseeable future and how many job openings will occur in the same period. Questionnaires were sent to all Federal Departments likely to employ botanists and all Botany and Biology Departments at Canadian Universities, and to individual graduate students and post-doctoral fellows in Canada. The report was compiled by J.A. Hellebust, G.N. Orlob and P. Sakhar, is entitled "**Botanists in Canada – supply and demand 1971-1975**" and was distributed to interested persons and departments.

It is unfortunate that many of the questionnaires were not returned. Information for the survey was received from 2 government departments, 22 university departments, 129 graduate students and 13 post-doctoral fellows – about 1/3 of the G.S. and P.D.F.'s approached.

The authors estimate that "153 positions might be available during the next 4 years. There are at present 227 Ph.D. students, 217 M.Sc. and 43 P.D.Fs. who are likely to apply for these jobs". Other quotes from this report:–

"The Dept. of Agriculture ... no new programmes are anticipated, except for a modest symposium in the area of environmental quality. B.Sc. graduates are in competition with Technology Institute graduates for technician positions. The National Research Council states that the employment opportunities for botanists now or in the next few years are rather grim."

"Most chairmen (of university departments) expect little change in numbers of graduate students in plant science .... over the next few years....".

The report presents a pretty gloomy picture of prospects for graduates in botany over the next few years. However it should be viewed in the light of another recent report – "**From Formalin to Fortran**" – a background study for the Science Council of Canada, special study no. 18 on basic biology in Canada, by P.A. Larkin and W.J.D. Stephen, Aug. 1971, obtainable from Information Canada. This 79 page report is an excellent "state of the union" assessment of the biological sciences in Canada and provides major guidelines for the future. It has a considerable bearing on the development of graduate studies in our universities and on the prospects for the employment of biologists. It should be prescribed reading for all biologists in Canada. The following quotations are taken from it.

..."for the readily foreseeable future, there will be hard competitive business reasons, convincing philanthropic reasons and compelling national social reasons for substantial investments in the life sciences in general and in the basic biological sciences in particular.

The national investment in "administratively uncommitted" research ... is a recognition that by preserving a range of interests, there is less chance of being caught lacking, and by encouraging unfettered scholarship, there is always a reservoir of informed and intellectually unprejudiced opinion.

Canada's problem is not whether to creep or to fly, but rather how to creep, run and fly all at once. We have only recently developed competence in some of the traditional areas of biology; yet to keep up with the times, we must do new things before we are properly ready to do many of the old.

Much of the background of systematics, morphology, plant and animal natural history, descriptive ecology, biogeography and paleontology has not yet been done in Canada to the level that has been achieved in Europe. Much of this work does not have much appeal from the point of view of those who wish to participate in the intellectual frontiers of biological science, but this is often what is necessary as a base from which to conduct those types of studies that will eventually lead to informed manipulation of natural environments. It is a feature of Canadian field biology that we are commonly trying to do sophisticated research without having a sufficient knowledge of the living or fossil materials that we are handling. No other technologically progressive country, except possibly Australia, has such a high proportion of unstudied floral and faunal elements.

We are perhaps fairly well equipped with a base from which to develop the strength we shall need in plant and animal physiology and biochemistry, though the university component of this activity is notably weak.

In the subject matter of microbiology, Canada has had a gathering record of achievement in agriculture and medicine, but it is only since 1950 that there has been any substantial development. Measured against the opportunities and problems of the future, our present level of effort is imprudently small.

Microbiology should be vigorously developed from its present nuclei of high quality in Canada. Attention should be given to ways of encouraging industry participation in this kind of work. Industrial research activity is our weak point.

Genetics is probably the most important subject in biology for which society of the future will require, as ingredients for its decisions, the sober judgements of its scientists. In an age that promises opportunities for selective breeding and control of the characteristics for every living thing, especially including man, failure to develop appropriate scientific strength could be tantamount to abdicating responsibilities. And yet the conclusion is inescapable that the particular kinds of research that have fundamental application to the problems of the future are generally not being carried forward in Canada.

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THE DALHOUSIE MEETINGS

Call for resolutions to be presented at the Annual Business Meeting. Resolutions, each with a mover and four seconders, and accompanied by a supporting brief, should be in the hands of any member of the Executive of CBA/ABC by April 1, 1972. This will permit publication of the resolutions in the Bulletin prior to the Annual Meeting. A list of members of the Executive Committee and their addresses was published in the July issue of the Bulletin. Please note the following **change of address**:– Dr. J.A. Fortin, Faculty of Forestry, Laval University, Quebec 10, P.Q.

DIRECTORY OF CANADIAN UNIVERSITY BIOLOGISTS

This directory has been produced as a computer print out by Dr. J.W. Green, Dept. of Biology, Laurentian University, Sudbury, Ont. It contains information under alphabetical list of names and under universities, of present location, date of present appointment, title, rank, department and area of interest.

THE BULLETIN

Material for inclusion in the April issue should reach me by the beginning of March – J.K. Morton, Editor, Dept. of Biology, University Waterloo, Waterloo, Ontario.

In the whole set of studies that centre around biology at the cellular and molecular level, Canada has had a conspicuously "latecomer" role. While present activity is by no means small or second rate, it is nevertheless small in relation to the development in other branches of biology and small in relation to the potentials and problems.

We do not have the people we need in molecular biology to keep us informed and aware of opportunities.

Cell biology is in better shape in Canada than is molecular biology, but again, like the rest of the sciences in that group, the broad picture, particularly at universities, is one of weakness.

The use of computers and mathematical techniques is generally weak in the biological sciences in Canada. Most of the panel reports are notable for their omissions in this regard. The panel report on biomathematics indicates that the ratio of scientists to statisticians is much higher than it is in the United States, the United Kingdom or Australia. In general, Canadian users of mathematics in biology are disturbingly few in relation to the opportunities. As in the case of cellular and molecular biology, we need specialists in the fields of mathematical biology, if only to keep abreast of the increasingly complex techniques and the intellectual depths of the science of the future.

For all of the current noise about ecology, ecologists still commonly persist in their syndromes of "one ecologist-one species" and "let's measure everything"–the first being characteristic of the autecologists who study the web of interrelations of a species, and the second of the synecologists who study the properties of plant and animal communities. As a result some of the simplest points of descriptive natural history have been repeatedly rediscovered. In attempts to try to look at too many things at once and to deal exclusively in "a posteriori" hypotheses, they have substantially developed the basic description of the natural world,but have discovered remarkably few new principles since Clements and Shelford, and Tansley and Elton and Leopold first put fine language around the simple truths of the "balance of nature".

The new ecology, which deals more in processes and experiment, is now well under way and ecology is rapidly evolving into a science. In this transition, Canada is in relatively good shape. There is strong emphasis on ecology in Canada because of its relevance to so many resource use questions. To make our contribution to world knowledge and to keep abreast of the field, it is probably necessary only to hasten the process of change, to back the "new ecology" with the type of "big project" thinking that it requires, and to make special efforts to bring physical scientists into team approaches.

For the new systematics, which is a twin of the new ecology, we are less well endowed. Modern concepts of evolution centre about the dynamics of ecological systems (hence "ecological genetics")– the ways in which natural selective processes preserve the moving equilibria of plant and animal associations. In the fast changing world of today, an understanding of these processes has wide and basic application.

New kinds of research may pose needs for new kinds of collaboration among various kinds of scientists. It is repeatedly stressed that the "big new gains" in understanding will come from "teams", and whether they are described as interdisciplinary of multidisciplinary, the message is always that one man rarely has the necessary total package of skills and perspectives. Investments that are aimed at producing true, world-class biological research must therefore be concentrated and appropriately integrated. It is a widespread view that modern biology is becoming more oriented to "problems" rather than disciplines. Research therefore proceeds in the direction that the problem suggests. The one-time "titan of science" who mastered many disciplines is a thing of the past. Replacing him is a leader and a mixed group of people who can collectively master the various aspects of the "problem".

Many biologists are convinced that the pace of biological research will be greatly quickened by encouraging physical scientists to tackle appropriate facets of biological problems.

The development of a new holism in Canadian science may thus be the most important step in keeping the country well ahead in the growth and application of science.

Canada urgently needs a set or regional laboratory facilities which provide excellent holding and controlled environment equipment for plants and particularly animals. For ecology and behaviour studies, these are particularly needed and would be highly useful for the complete spectrum of studies that have a bearing on questions of environmental effects. Major research facilities, such as the controlled environment greenhouse at the University of Alberta and the Marine Sciences Research Laboratory at Logy Bay in Newfoundland (which were built with National Research Council major installation grants), are very desirable investments. Hopefully, many similar installations will develop in the future.

At the level of the individual laboratory, requirements for new and major equipment are increasingly to be expected. The modern biologist needs much of the same equipment as those in the physical sciences, and he has the added problems of maintaining and studying perishable living materials.

To meet the need for ever more sophisticated and expensive equipment, biologists, and particularly their administrations, should be thinking in terms of a new scale of expenditure for the future.

The state of our National Museum deserves a particular comment because it is pathetic by old-world international standards.

It would probably be desirable to split the various roles of traditional museums and to have each performed in its most appropriate milieu. The public display and showmanship jobs should be turned over to the cultural agencies. Development of the activities of modern research systematics should be centered in universities.

The truly museum activities, those that centre around the bookkeeping of scientific material, classical systematics and the largely technical jobs of identification (a necessary service to many other branches of biology), should be set up under a single administration (perhaps under the National Research Council) in a similar fashion to a national library service. There should be a large central repository and a network of national regional museums.

The one great contemporary need of Canadian biology is for devices that will give it more cohesion, more of a single voice, and more of the internal communication, that is necessary if it is to serve society effectively.

In the non-medical areas, university biologists are only half as numerous as government biologists, and that the total number of biologists in arts and science and science faculties is a small group in the overall total of life scientists in Canada. In developing Canadian biology for the future, it must be recognized that in the past there has been a substantial applied overtone to most of our activity.

If the shift is not toward the growth of academic science, we are much more likely to perpetuate our current weaknesses. While the status quo is perhaps adequate for the transition period, there can be no doubt that the long-term drift must be toward proportionately more university research that is "administratively uncommitted".

(National Research Council) awards to biology are roughly 23 per cent of the total in science, and biologists are roughly 25 per cent of the total number of applicants. In these circumstances, it is surprising that there is only one biologist on the 18-member Council. Bearing in mind that biology shows signs of being the biggest science of the future, and that it already has great breadth and social importance, it is apparent that biology should be better represented.

Each year four biology grant selection committees of the National Research Council decide on the distrubition of about $9 million among more than 1000 applicants.

The procedure of deciding on awards is basically similar in the four committees (cell biology, animal biology, plant biology and population biology). Seven or eight Canadian university scientists, representative of the various facets of the subject matter and of the various parts of the country, review in excess of 200 requests in no more than 2-1/2 days. If 2-1/2 days represents 20 working hours, no grant application receives more than six minutes consideration (three minutes would probably be closer to the norm).

The system relies heavily on committee members doing their homework, and on their familiarity with the work that is going on in the country. There can be little question that, despite every attempt to be completely fair, the committee may sometimes play favourites of one kind or another, and with respect to the people they know less well, may dispense some random justice.

All things considered, the present system of making awards, while casual in appearance, seems to provide a reliable but somewhat erratic system of judging on substance.

There are three possible needs for the future–a greater number of committees, more rigorous review procedures, and a parent committee to consider matters of policy.

The use of outside referees could strengthen the selection procedures.

The present procedures of peer judgement seem the only safe guide in the subjective circumstances. To the degree that they err because of ignorance, they are more likely to favour charity, giving the benefit of doubt to the applicant.

The question continues to arise, "Who will support the person of very limited competence whose application is rejected by NRC but whose participation in research is deemed desirable as an aid to good teaching?" The answer seems to be that the universities should provide this support, doing so to the degree that they believe in what they so frequently say on the subject (and doing so with funds other than those for "overhead" from NRC).

It is to be underlined that regional or subject matter preferences, and especially the degree of "mission orientation", should be vigorously excluded from the considerations of the grant selection committees. If they were to judge on any other basis than merit, they would lose all credibility in the eyes of their colleagues.

In recent years the proposal has been debated that graduate student support should be separated from operating grant requests, federal funds for student support going to universities to administer.

A national conference, involving many representatives of the graduate student body, would seem to be a very desirable way of starting a review that would lead to any needed reform.

It should be clearly appreciated that, if it is the object of the National Research Council to support excellence, then there should be fewer grants and bigger grants mostly to people in the bigger institutions. Whether policy should be so single-minded is another question. . . "

The above quotations out of **"From Formalin to Fortran"** should provide ample food for thought and a basis for discussion amongst botanists in our universities and other centres of botanical research! Ed.

Graduate Studies in Botany
at Canadian Universities

Compiled by Bryce Kendrick
Dept. of Biology, University of Waterloo

"The present possibility of overproduction of Ph.D. graduates in biology should not be viewed with undue concern. The long term demand is good . . . " – From Formalin To Fortran

When the C.B.A. asked me to attempt this compilation, I wrote to every degree-granting institution in Canada, and received many replies indicating that higher degrees (M.Sc. and Ph.D.) were not granted by most of them. Conspicious among non-respondents, however were a number of universities which certainly do grant higher degrees in Botany. To these I wrote again, and gleaned a few more replies.

I regret that the list is still incomplete, and is also, like many other publications, slightly out-of-date when it appears, but I still hope that it may be of some use to students considering graduate work in Botany, and will show them that they need not look south of the border for competent supervision in their chosen field.

UNIVERSITY OF ALBERTA, Edomonton, Alberta,
Department of Botany, 14 botanists
Dr. Paul R. Gorham, Chairman
Graduate Degrees Offered: M.Sc., Ph.D.

L.C. Bliss, Professor, M.Sc., Ph.D.
Plant Ecology; physiological ecology; arctic and alpine ecosystems.
D.D. Cass, Assistant Professor, M.S., Ph.D.
Plant anatomy; angiosperm embryology
E.A. Cossins, Professor, B.Sc., Ph.D.
Plant Biochemistry; synthesis and metabolism of amino acids and pteroylglutomate derivatives.
K.E. Denford, Assistant Professor, B.Sc., Ph.D.
Chemotaxonomy; chemosystematics in relation to origins and distributions.
P.R. Gorham, Professor, M.S., Ph.D.
Plant Physiology; phloem translocation, toxic blue-green algae, aquatic macrophytes
M. Hickman, Assistant Professor, B.Sc., Ph.D.
Phycology; ecology and primary producitivity of benthic algae communities.
L.L. Kennedy, Professor, M.Sc., Ph.D.
Mycology; development, taxonomy, and ecology of wood decaying fungi.
G.H. La Roi, M.A., Ph.D., Associate Professor,
Plant Ecology; synecology of Rocky Mountain forests and western boreal taiga; vegetation analysis; population dynamics.
S.K. Malhotra, Professor, M.Sc., Ph.D., D. Phil.,
Electron microscopy; structure and biogenesis of cell membranes.
J.M. Mayo, M.S., Ph.D., Assistant Professor,
Plant Physiology; plant water relations in controlled environments; net assimilation studies.
J.G. Packer, Associate Professor, B.Sc., Ph.D.
Taxonomy; circumpolar arctic and alpine taxa.
W.N. Stewart, Professor, M.S., Ph.D.,
Paleobotany; micro and megafossils of the Cretaceous.
D.H. Vitt, Assistant Professor, M.S., Ph.D.,
Bryology, Lichenology; ecology, biosystematics and evolution of bryophytes.
G.D. Weston, Assistant Professor, B.A., Ph.D.,
Plant Physiology; growth and development of roots.

UNIVERSITY OF BRITISH COLUMBIA, Vancouver, B.C.
Department of Botany, 20 botanists
Degrees Offered: M.Sc., Ph.D.

Biochemistry: B.A. Bohm, B.R. Green, G.H.N. Towers, I.E.P. Taylor
Biogenesis and metabolism of phenolic compounds in plants. Chemical taxonomy. Nuclear and cytoplasmic DNA's of plants; electron microscopy, base composition; Morphogenesis of Acetabularia; comparative plant biochemistry; structure of plant proteins, structure and function of cell wall components.
Bryology: W.B. Schofield
Geography, systematics and ecology – particularly mosses
Cytology: T. Bisalputra, K.M. Cole
Ultrastructure and cytochemistry of Algal Cells, particularly the photosynthetic system and cell wall. Cytology of vascular plants; Cytology and cytogenetics of marine algae (including ultrastructure of Phaeophyceae and Rhodophyceae).
Ecology: V.J. Krajina, J.R. Maze
Experimental plant autecology; biogeochemical cycling; plant communities and biogeoclimatic zonation; Pacific Northwest, Canadian Arctic, Hawaiian Islands; Nature conservation; relationship between hybridization and ecology; floret development and embryology in grasses and the relation to their phylogeny.
Genetics: C. Person
Genetics; including studies of parasitic microorganisms.
Mycology: R.J. Bandoni, G.C. Hughes
Studies of the lower Basidiomycetes, especially the Tremellales; taxonomy and ecology of aquatic fungi; Saprolegniales, marine Ascomycetes and Fungi Imperfecti.
Palynology: G.E. Rouse
Palynology of Cretaceous & Tertiary sediments in Canada emphasizing microfossil taxonomy, palaeoecology, and reconstructions.
Phycology: I.R. Stein, R.F. Scagel, F.J.R. Taylor
Morphology and genetics of algae; distribution of fresh-water algae in British Columbia. Field and laboratory culture studies of marine benthonic algae; taxonomy; morphology and ecology; marine phytoplankton; toxonomy, morphology and ecology of populations within the North Pacific and Indian Ocean; "red tides"; benthic micro-organisms.
Plant Physiology: E.B. Tregunna, D.J. Wort
Effects of environments on plant metabolism; chemical growth regulation.
Taxonomy: K.I. Beamish
Cytotaxonomic studies in native British Columbia genera.

Director of Botanical Garden: R.L. Taylor
Biosystematic research on vascular plants of the Cordilleran region; AIBS Flora North America Project.

UNIVERSITY OF CALGARY, Calgary, Alberta, Canada.
Department of Biology, 7 botanists
Degrees Offered: M.Sc., Ph.D.

J.D. Bewley
Physiological and chemical control of seed dormancy and germination; biochemical action of phytohormones (especially gibberellins); inter-relationship between phytochrome action and gibberellin synthesis.
C.D. Bird
Floristics, ecology and systematics of lichens and bryophyta.
R.T. Ogilvie
Ecology of High Mountain Vegetation, ecology of alpine plant communities, ecology of timberline; distribution and evolution of western mountain plant species, distributional range of cordilleran species in western Canada, evolutionary relationships, morphology and taxonomy of Picea in western Canada.
R.P. Pharis
Physiology of plant growth and development, especially physiology and biochemistry of the gibberellins.
D.M. Reid
Plant hormones and phytochrome: developmental physiology of plants, especially sites of synthesis of gibberellins, both intracellular and intercellular; effects of red and far red light on gibberellin levels; effects of water-logging on growth and gibberellin content; gibberellin metabolism in tissue cultures; mode of action of growth retarding chemicals.
B.C. Sharman
Morphogenesis and developmental anatomy of cereals and herbage (range) grasses; production, by 2,4-D of abnormalities in the inflorescence in cereals.
T.A. Thorpe
Morphology, physiology and biochemistry of organ initiation in tissue culture systems; biosynthetic capacity of callus tissue with respect to secondary metabolism, mainly phenolics and isoprenoid derivatives; role of growth regulators and other organic addenda in callus growth and organization; use of tissue culture techniques and principles for plantlet propagation in excised plant parts and callus derived therefrom.

CARLETON UNIVERSITY, Ottawa, Ontario,
Department of Biology, 11 botanists
Degrees Offered: M.Sc., Ph.D.

Ecology and Systematics

I. Bayly
Wetland ecology; ecotypic variability in vascular plants.

W.I. Illman
Ecological physiology of plant parasitic fungi; systematic mycology.

J.D.H. Lambert
Quantitative plant ecology; vegetation analyses in Arctic and forest environments.

Molecular and Cellular Biology

V.N. Iyer
Genetic organization and function in bacteria and their viruses.

P.E. Lee
Characterization of insect-transmitted viruses and insect viruses.

M. McCully
Cytology, histology, and histochemistry in relation to plant development.

Physiology

K.W. Joy
Nitrogen metabolism in plants. Enzymology of nitrate reduction and assimilation; sterile plant culture.

J. Sinclair
Photosynthetic oxygen evolution and light sensitive movements.

J.A. Webb
CO_2-assimilating pathways in plants, synthesis, metabolism and transport of sugars in plants.

F. Wightman
Biochemistry of plant growth, particularly metabolism of amino acids and biosynthesis of growth hormones.

UNIVERSITY OF GUELPH, Guelph, Ontario
Department of Botany, 13 botanists
Acting Chairman: Dr. G.L. Barran
Degrees Offered: M.Sc., Ph.D.

G.L. Barran, Professor
Soil mycology.

D.M. Britton, Professor
Cytotaxonomy of ferns. Dryopteri spp.

H.M. Dale, Professor
Ecology of weeds and aquatic plants.

J. F. Gerrath, Assistant Professor,
Phycology. Taxonomy and cytology of Desmids. Algae of Wellington and adjacent counties.

R.F. Horton, Assistant Professor,
Plant physiology. Hormonal regulation of plant growth.

B.C. Lu, Assistant Professor,
Karyology and genetics of basidiomycetes

H. Lue Kim, Assistant Professor,
Plant Physiology.

R.L. Peterson, Assistant Professor,
Developmental morphology.

W.E. Rouser, Associate Professor,
Plant physiology. Biochemistry and mineral nutrition.

R.T. Riddell, Professor
Tissue culture.

S.J. Rigby, Assistant Professor,
Cytogenetics of ferns. Pallaea.

D.W. Smith, Assistant Professor,
Ecology. Succession in disturbed areas.

R.E. Subden, Assistant Professor,
Neurospora genetics. Carotenoid biosynthesis.

UNIVERSITE LAVAL, Quebec, P.Q.
Department de biologie, 3 botanists
Dr. Lucien Huot, Directeur
Degrees Offered: M.Sc., Ph.D.

A. Cardinal, Professeur adjoint, M.Sc., D.Sc.
Taxonomy and ecology of marine algae

J. Lafontaine, Professeur, Ph.D.
Electron microscopy; ultrastructural study of mitosis in plant meristematic cells.

P. Morisset, Professeur adjoint, Ph.D.
Flowering plant biosystematics; phytogeography; cytogenetics.

MCMASTER UNIVERSITY, Hamilton, Ontario, Canada.
Department of Biology, 7 botanists
Degrees Offered: M.Sc., Ph.D.

D. Davidson
Cell proliferation; analysis of cell population; cytology and development; morphogenesis; responses to drugs and radiations.

G.P. Harris
Systems analysis of woodland canopies emphasising the inter-relations between microclimate and epiphyte physiology.

K.A. Kershaw
Ecology and systems analysis of tundra and northern coniferous forests.

J.N.A. Lott
Ultrastructure of storage tissues in seeds.

J.J. Miller
Metabolism of yeast sporulation and spore germination.

B.A. Oaks
Regulation of nitrogen metabolism during seed germination.

S.F.H. Threlkeld
Genetics of fungi.

UNIVERSITY OF MANITOBA, Winnipeg, Manitoba
Department of Botany, 11 botanists
Professor E.R. Waygood, Chairman
Degrees Offered: M.Sc., Ph.D.

W.G. Barker
Effect of chemical and physical factors on plant growth and development; differentiation in cell, tissue, and organ cultures.

L. van Caeseele
Optical and electron-microscopy of cells and microorganisms.

B.R. Irvine
Intermediary plant metabolism, enzymology, photosynthesis and respriation; associated with Plant Pathology and Ecology programmes. Host-parasite relations; vascular parasites, forest pathology and virus diseases of cereal crops.

P.K. Isaac
Physiology of filamentous fungi; developmental morphology and taxonomy of the Ascomycetes. Optical and electron-microscopy of cells and micro-organisms.

R.E. Longton
Bryology and Arctic and Antarctic Ecology.

D. Punter
Host-parasite relations; vascular parasites, forest pathology, and virus diseases of cereal crops.

J. Reid
Physiology of filamentous fungi; developmental morphology and taxonomy of the Ascomycetes.

G.G.C. Robinson
Experimental ecology of fresh water algae. Cytology and cytogenetics of algae.

J.M. Stewart
Ecosystem studies; the ecology of wetlands incorporating studies of dynamics, energetics and productivity of Phragmites, Zizania and other species.

J.M. Walker
Ecosystem studies; the ecology of wetlands incorporating studies of dynamics, energetics and productivity of Phragmites, Zizania and other species.

E.R. Waygood
Intermediary plant metabolism, enzymology, photosynthesis and respiration; associated with Plant Pathology and Ecology programmes.

MEMORIAL UNIVERSITY OF NEWFOUNDLAND, St. John's Nfld.
Department of Biology, 4 botanists
Dr. Marshall Laird, Chairman
Degrees Offered: M.Sc., Ph.D.

A.K. Bal
Cellular Biology, ultrastructure and macromolecular synthesis in differentiating plant cells.

G. Moskovits
Aquatic microbiology with special emphasis on taxonomy, distribution and ecology of bacteria and phytoplankton.

O.A. Olsen
Collection and identification of the macrofungi of Nfld., also the isolation of entomogenous fungi from insects.

G.R. South
Marine phycology, ecology, distribution and experimental culture of marine algae with specific reference to benthic forms.

UNIVERSITY OF MONTREAL, Montreal, P.Q.
Department of Biology, 8 botanists
Degrees Offered: M.Sc., Ph.D.

J.R. Beaudry
Genetique des Champignons (Ascobolus).

J. Brunel
Ecologie et systematique du phytoplancton dulcicole et marin.

M. Cailloux
Mecanism cellulaire de l'absorption de l'eau par les poils radiculaires. Formation de la seve chez l'Erable a sucre.

Y.S. Chung
Genetique des microorganismes (e.g. bacteries, virus).

M. D'Aoust
Biologie moleculaire du Chloroplaste.

R. Gauthier
Etudes comparees d'anatomie florale.

E. Rouleau
Taxonomie vegetale de Terre-Neuve et du Quebec. Flore de l'Est du Canada.

J. Vieth
Anatomie florale, normale et pathologique.

UNIVERSITY OF OTTAWA, Ottawa 2, Ontario
Department of Biology, 4 botanists
Degrees Offered: M.Sc., Ph.D.

F. LeBlanc
Bryology and Ecology
C. Nozzolillo
Physiology and Biochemistry
R. Reed
Ecology
P. Weinberger
Physiology

QUEEN'S UNIVERSITY, Kingston, Ontario
Department of Biology, 12 botanists
Degrees Offered: M.Sc., Ph.D.

Plant Physiology and Plant Biochemistry
R.G.S. Bidwell, K. Budd, D. Canvin, D.T. Dennis
Photosynthesis, respiration, plant metabolism, lipid metabolism, enzyme regulation; analysis with gas-liquid chromatography, radioisotope techniques; tree, environmental and fungal physiology.
Experimental Mycology
K. Budd, F. Cooke, H.M. Good and C.H. Hood
Physiology, ecology, genetics and fine structure of fungi. The ecology includes aspects of plant and forest pathology and genetics of pathogenicity. The physiology of fungi concentrates on ion uptake and carbon metabolism.
Plant Ecology and Taxonomy
E.C. Pielou and W.J. Roff
Gradient analysis and mapping of vegetation and flora in the Arctic and Eastern Ontario; dendrochronology and lichenometry; autecology and synecological studies of wetlands; population ecology; studies of plant competition; experimental taxonomy; mathematical ecology.
Cell Biology
J.M. Bristow and A.B. Cairnie
Control of cell renewal and of growth and differentiation in various plant and animal tissues; the effects of physical and chemical factors.
Radiobiology
C.H. Hood and A.B. Cairnie
The response of cellular systems in plants and animals to UV and X radiation.

UNIVERSITY OF SASKATCHEWAN (Regina Campus), Regina, Saskatchewan
Department of Biology, 4 botanists
G.F. Ledingham, Chairman
Graduate Degrees Offered: M.Sc., Ph.D.

G.F. Ledingham
Cytotaxonomy and evolution of flowering plants; experimental taxonomy.
W.A. Quick
Physiology of host-parasite relations; physiology of herbicides; physiology of senescence.
M.V.S. Raju
Plant embryology; plant anatomy, plant growth and development.
A. Walther
Plant senescence; cold hardiness.

UNIVERSITY OF SASKATCHEWAN, Saskatoon, Saskatchewan
Department of Biology, 11 botanists
Degrees Offered: M.Sc., Ph.D.

T.J. Arnason
Induced mutagenesis in Hordeum and Arabidopsis. The nature of mutational changes.
L.C. Fowke
Structure and function of plant cell organelles during cellular growth and differentiation. Light and electron microscope studies of cell division in algae.
H.E. Gruen
Physiology of growth and development in fungi. Internal growth regulation in fruit bodies of higher fungi (Agaricales) and in sporangiophores of Phycomyces.
V.L. Harms
Plant biosystematic studies in various angiosperm groups, including Heterotheca (Chrysopsis), Petasites, Sparganium, and Artemisia. Floristic and distributional studies of Saskatchewan vascular plants.
J. King
Nitrogen metabolism of soybean and wheat cells in culture. Enzymology; kinetics of transport of amino acids and other nitrogen sources across cell membranes.
R.A.A. Morrall
Plant pathology and soil microbiology, the ecology and epidemiology of plant pathogens; root disease fungi; the ecology of sparophytic soil fungi.
J.M. Naylor, Head
Cytological and cytochemical studies of growth regulation in higher plants. Problems in dormancy of buds and seeds.
B.M. Rever
Genecological studies on seleniferous plants in North America. Evolutionary significance of selenium accumulation in Astragalus.
J.W. Sheard
Lichen taxonomy, particularly of crustaceous genera; phytosociology. The application of ordination and classification techniques in these disciplines.
T.A. Steeves
Developmental and experimental plant morphology
F. Turel
Physiology of the flax rust, Melampsora lini.

UNIVERSITY OF SASKATCHEWAN, Saskatoon, Saskatchewan,
Department of Plant Ecology, 5 botanists
Degrees Offered: M.Sc., Ph.D.

R.T. Coupland, Ph.D.
Grassland Ecology
V.L. Harms, Ph.D.
Systematic Botany
R.E. Redmann, Ph.D.
Physiological Ecology
E.A. Ripley,
Micrometeorology
J.S. Rowe, Ph.D.
Forest and Wildland Ecology

SIMON FRASER UNIVERSITY, British Columbia
Department of Biological Sciences, 12 botanists
Degrees Offered: M.Sc., Ph.D.

L.J. Albright, Assistant Professor, Ph.D.
Marine microbiology, hydrostatic pressure, salinity and temperature effects on growth and physiology of marine microbes.
R.C. Brooke, Associate Professor, Ph.D.
Plant ecology, microenvironmental relationships, physiological ecology.
L.D. Druehl, Assistant Professor, Ph.D.
Phycology, Biological oceanography, marine ecology.
F.J.F. Fisher, Professor, Ph.D.
Leaf morphogenesis, experimental taxonomy, eco-physiology, evolution, human ecology.
C.L. Kemp, Assistant Professor, Ph.D.
Biochemical cytology, genetics, cell biology, virus morphogenesis.
G.R. Lister, Assistant Professor, Ph.D.
Plant Physiology, translocation, physiological integration, physiology of forest trees.
M. McClaren, Assistant Professor, Ph.D.
Genetics of Fungi, particularly of higher basidiomycetes, meiotic cytology of basidiomycetes, Fungal ecology.
P.C. Oloffs, Assistant Professor, Ph.D.
Pesticide Chemistry and Toxicology.
H.L. Speer, Assistant Professor, Ph.D.
Photobiology, biochemistry.
L.M. Srivastava, Associate Professor, Ph.D.
Histology, ultrastructure, morphology of higher plants, electron microscopy.
W.E. Vidaver, Professor, Ph.D.
Photobiology, plant physiology, hydrostatic pressure effects on biological systems.
J.M. Webster, Associate Professor, Ph.D.
Plant and insect nematology, insect pathology, parasitology, host parasite relationships.

UNIVERSITY OF VICTORIA, Victoria, British Columbia
Department of Biology, 6 botanists
Degrees Offered: M.Sc., and Ph.D.

A.P. Austin
Freshwater phycology.
D.J. Ballantyne
Plant physiology.
M.A.M. Bell
Plant Communities
J.N. Owens
Plant Morphogenesis
L.A. Hobson
Phytoplankton and physiology
J. Paden
Mycology.

UNIVERSITY OF WATERLOO, Waterloo, Ontario
Department of Biology, 7 botanists
Dr. P.S. Corbet, Chairman
Degrees Offered: M.Sc., Ph.D.

E.B. Dumbroff, Associate Professor, M. Forestry, Ph.D.
Plant physiology; mineral nutrition and salt tolerance of higher plants; mechanisms of seed dormancy.
H.C. Duthie, Associate Professor, B.Sc., Ph.D.
Freshwater ecology; ecology of algae; phytoplankton proficutivity.
H.R.N. Eydt, Associate Professor, M.Sc., Ph.D.
Quarternary paleoecology
W.B. Kendrick, Professor, B.Sc., Ph.D.
Taxonomic and developmental mycology; taxonomic theory; taxonomic applications of computers.
J.K. Morton, Professor, B.Sc., Ph.D.
Flowering plant biosystematics, ecology and geography
J.E. Thompson, Assistant Professor, B.S.A., Ph.D.
Membrane structure and function; membrane biosynthesis.
K. Zachariah, Assistant Professor, M.A., Ph.D.
Electron microscopy; developmental and cytological studies on lower plants.

UNIVERSITY OF WINDSOR, Windsor 11, Ontario
Department of Biology, 6 botanists
Degrees Offered: M.Sc., Ph.D.
Dr. R.J. Doyle, Head.

M.M. Abdel-Sayed
Virology of plants; biological transmission of plant viruses – their purification and physiochemical characteristics.
W.G. Benedict
Plant pathology; physiological and phytochemical aspects of plant-parasite relationships.

D.T.N. Pillay
Plant physiology; mode of action of growth promoting and retarding substances in plant growth.
D. des S. Thomas
Developmental plant morphology; emphasis on mechanisms controlling cell wall development.
D.G. Wallen
Physiological algal ecology; ecology of plankton algae, adaptation to different light intensities, wavelengths and temperatures.