Entomological Manpower

in

Canada

Current Status

and

Future Projections

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Entomological Manpower in Canada — Current Status and Future Projections[1]

F. L. McEwen[2], C. R. Harris[3], A. J. McGinnis[4]

Abstract

A survey of the entomological manpower in Canada was sponsored by the Public Service Commission of Canada and funded by the Department of Supply and Services. The objectives of the survey were to develop an inventory for graduate students. In addition, an attempt was made to develop a realistic demand picture for entomologists in Canada over the next decade taking into account retirements, shifting emphasis on programs, and new developments.

The survey was conducted in 1975 by a professional consultant. Appropriate questionnaires were prepared and sent to entomologists in Canada, graduate students in entomology, and employers of entomologists. The results were compiled, summarized and analyzed by computer.

Four hundred and sixty-nine entomologists responded to the questionnaire. They are employed primarily by the Government of Canada (225), Educational Institutions (139), Provincial Governments (67), and Industry (18). In descending order, the primary functions of the respondents are research, teaching, administration, and extension. The average age of the respondents was 44 years. Nearly two-thirds of the federally-employed entomologists are above this age.

The Federal Government and Educational Institutions employ a much higher proportion of entomologists with doctorates than do the other employers. Salaries for entomologists in Canada range from less than $10,000. to more than $30,000. with a mean of $21,775. per year.

Only about 40% of the respondents employed by the Federal Government and Industry plan to work until age 65. In contrast, the figures for Educational Institutions and Provincial Governments are 77% and 57%, respectively.

One hundred and twenty-four graduate students responded to the questionnaire. Of these, 73 were indentified in Master's programs and 47 in Ph.D. programs. About 70% of the students are associated with six institutions. The two sub-disciplines which are currently most attractive to graduate students are applied pest control (biological) and ecology. Of the 124 respondents, 102 expect to complete their graduate programs and be available for employment by 1977.

A questionnaire was sent to 80 employers requesting information and projections on current and future demand for entomologists in Canada; 57 responded. The most optimistic prediction for the next decade calls for a total of 66 new positions in all employment sectors.

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[1]This study supported by the Department of Supply and Services Canada, Ottawa.
[2]Department of Environmental Biology, University of Guelph.
[3]Research Institute, Agriculture Canada, London, Ontario.
[4]Research Station, Agriculture Canada, Vineland Station, Ontario.

An attempt was made to match supply of, and demand for, personnel within sub-disciplines. The data indicate, based on present enrolment in graduate programs, that the areas of applied pest control (biological), ecology, and physiology are over subscribed. Disease transmission and applied pest control (chemical) are the only sub-disciplines in which expansion is indicated.

From this study the consultant concluded:

a) There is an imbalance between the projected supply of entomologists and job opportunities.
b) There is currently a pessimistic attitude among entomologists and their employers with respect to future support.
c) Forward planning in the Federal Government is essential to avoid imbalance between supply and demand, and to permit reasoned and orderly recruitment.

Resumé

Un sondage de la main-d'oeuvre entomologique au Canada fut conduit en 1975 par un consultant professionnel. Cette étude, parrainée par la Commission de la Fonction Publique fut supportée financièrement par le Ministère des Approvisionnements et Services du Canada. Ce sondage avait pour but de développer un inventaire des entomologistes professionnels au Canada et de développer parallèlement un inventaire des étudiants gradués. Aussi, une tentative fut faite de brosser un tableau réaliste des besoins futurs d'entomologistes au Canada pour les dix prochaines années tout en tenant compte des retraités à venir, du changement d'emphase des programmes de recherche et des nouveaux développments. Un questionnaire fut préparé et envoyé aux entomologistes au Canada, aux étudiants gradués en entomologie et employeurs d'entomologistes. Les résultats furent compilés, abrégés et analysés à l'aide d'un ordinateur.

Quatre cent soixante-neuf entomologistes répondirent au questionnaire. Ils sont employés principalement par le Gouvernement du Canada (225), les Institutions d'enseignement (139), les Gouvernements provinciaux (67), et l'Industrie (18). L'ordre d'importance des fonctions est la recherche, l'enseignement, l'administration et l'extension. Leur âge moyen était de 44 ans. Près des deux tiers des entomologistes à l'emploi du gouvernement fédéral sont au dessus de cet âge.

Le gouvernement fédéral ainsi que les institutions d'enseignement emploient proportionellement plus d'entomologistes au niveau du doctorat que les autres employeurs. Les salaires des entomologistes varient entre moins de $10,000. à plus de $30,000. avec une moyenne de $21,775. par année.

Seulement 40% environ des employés fédéraux et de l'industrie, ayant répondu au questionnaire, projettent de travailler jusqu'à 65 ans. Cependant dans les institutions d'enseignement et gouvernements provinciaux les pourcentages sont de 77 et 57 respectivement.

Cent vingt quatre des étudiants gradués répondirent au questionnaire; 73 furent indentifiés au niveau de la maîtrise et 47 au niveau du doctorat. Environ 70% des étudiants se retrouvent dans six institutions. Les deux sous-disciplines qui attirent présentement le plus d'étudiants gradués sont la lutte appliquée contre les ravageurs (biologique) et l'écologie. Des 124 qui ont répondus, 102 projettent de terminer leurs études et être disponibles pour être employés en 1977.

Un questionnaire fut envoyé à 80 employeurs leur demandant d'indiquer les besoins immédiats et futurs d'entomologistes au Canada; 57 répondirent. Les prédictions les plus optimistes pour les 10 prochaines années indiquent qu'il y aura environ 66 nouveaux postes ouverts pour tous les secteurs d'occupation.

On a tenté de mesurer l'offre et la demande en personnel à l'intérieur des sous-disciplines. En se basant sur le nombre d'étudiants gradués, les secteurs lutte appliquée contre les ravageurs (biologique), l'écologie et la physiologie sont saturés. La sous-discipline concernant la transmission de maladies et lutte appliquée contre les ravageurs (chimique) sont les seules disciplines ou une expansion est indiquée.

De cette étude le consultant retire les points suivants:

a) Il y a un déséquilibre entre l'offre et la demande d'entomologistes et les possibilités d'emplois.
b) Il y a en ce moment un climat pessimiste parmi les entomoligistes et leurs employeurs en ce qui concerne l'avenir.
c) Une planification à long terme au sein du gouvernement fédéral est essentielle afin d'éviter un déséquilibre entre l'offre et la demande, et de permettre un recrutement raisonné et ordonné.

Introduction

During the past decade, there has been a substantial decrease in the number of entomologists employed by the Public Service in Canada. This has been of concern to the Entomological Society of Canada, since it reflects a low priority for entomology at a time when insects are causing increased losses to food and fibre production in Canada and when insects have become increasingly important to the health and welfare of Canadians. The Entomological Society of Canada wished to know the status of the entomological profession with regard to entomologists currently working in Canada and students pursuing this as a career at graduate levels in Canadian universities. The Society believes that such information is critical, not only to the entomological profession itself but also to the federal government and other employers responsible for the production of food and fibre, the protection of natural resources, the stewardship of the Canadian environment and the health and welfare of Canada's people. It is equally important that the universities responsible for the training of entomologists be aware of the need for this service as a basis for setting priorities in training programs. To develop this information, the Entomological Society of Canada employed a consultant[5] with the following terms of reference:

1. To develop an inventory of professional entomologists in Canada and a profile of that inventory with respect to education and employment and such other criteria as might be found important during the study in describing the professional population.

2. To develop an inventory and profile of Canadian graduate students in entomology, their sub-discipline and expectations as to employment, and other relevant information.

3. To assess Canada's demand for entomologists (indentified at the sub-disciplinary level) over the next ten years, on the basis of:

   a) Replacements for those retiring
   b) Projections for shifting emphasis in existing programs
   c) Projections for new needs for entomologists in Canada in relation to their role in food supply, faunistic studies, protection of the environment, development of northern areas and development of optimum systems for resources management

4. To project a realistic and informed pattern of requirements for entomologists over the next decade.

The study was completed in March of 1976 and serves as the basis for this report.

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[5] Potentia Consultants Ltd.

Methodology and Data Sources

The consultants worked closely with the Manpower Committee of the Entomological Society of Canada (C.R. Harris, F.L. McEwen, A.J. McGinnis). Using the membership list of the Entomological Society of Canada and those of affiliated entomological societies, the Manpower Committee and the Regional Directors of the Society provided lists of the professional entomologists in Canada. A questionnaire was then sent to each of these entomologists. Graduate students in entomology in Canada were similarly canvassed. The chairman of each university department in Canada where entomology graduate students are taught, was asked to provide a listing of the entomology graduate students in that university. The information received was encoded and key-punched to provide a source deck of computer card encoded data. The cards were then read into an I. P. Sharp timesharing IBM/370-145 computer and the data processed using the APL 'FELLO' program developed by Dr. Murray Shaw of the Human Resources Planning Division, Public Services Commission of Canada. The data source for the demand information was a questionnaire distributed to major employers across Canada. Questionnaires were sent to 80 employers, employing 324 of the entomologists in Canada.

Results

Professional Entomologists

(a) Current Employment —

Of the entomologists canvassed, the 469 (68%) who responded to the questionnaire[1] are employed primarily by four sectors, the federal government, provincial governments, industry and educational institutions (Table 1.)

Table 1. Entomologists employed in each province in Canada by major employers.

	Number employed by:					
Province	Federal Government	Provincial Government	Industry	Educational Institutions	Other	TOTAL
British Columbia	32	8	2	19	5	66
Alberta	22	15	0	11	2	50
Saskatchewan	21	8	0	7	1	37
Manitoba	23	4	1	9	2	39
Ontario	81	3	10	52	4	150
Quebec	15	17	2	23	5	62
New Brunswick	13	3	0	4	0	20
Nova Scotia	9	7	1	6	1	24
Prince Edward Island	2	0	0	2	0	4
Newfoundland	6	2	0	3	0	11
Other	1	0	2	3	0	6
Total	225	67	18	139	20	469

[1] For purposes of this presentation, this sample is considered to represent the population of entomologists in Canada.

The federal government is the largest employer, employing almost 50% of the population. Most entomologists work in Ontario, followed by British Columbia, Quebec and Alberta. The largest number of entomologists in the federal government educational institutions, and industry, work in Ontario. Quebec and Alberta are the largest provincial government employers of entomologists.

Entomologists are employed in Canada in a variety of functions (Table 2). Approximately one-half (232) identified research and 92 indicated teaching as their main responsibility. A surprisingly large number (50) function as administrators. Table 2 indicates only the major responsibility of respondents. However, many have more than one function; most teachers indicated a large research component in their responsibilities and a significant number of both teachers and research workers indicated an extension component.

Table 2. Entomologists employed primarily in each function.

Function	No. Employed
Research	232
Teaching	92
Administration	50
Extension	29
Consulting	14
Survey	12
Technical Development	11
Pest Control Operators	8
Regulatory	6
Other	15
Total	469

Entomologists were asked to identify the sub-discipline which best characterized their work (Table 3). The largest group (92) indicated insect ecology as their field, and this was followed in decreasing order by applied control (chemical), systematics, applied control (biological), physiology and general entomology. Only a small number work in the sub-disciplines of toxicology, apiculture, disease transmission and morphology.

Ecologists are employed, primarily, by the federal government and educational institutions. Those working in applied control (chemical) are employed primarily by the federal government, provincial government and industry. By contrast, relatively few of those working in applied control (biological) are employed by provincial governments or industry.

The largest sub-disciplinary groups within the federal government are insect ecology, applied control (biological), systematics and applied control (chemical). While the universities employ a relatively large number of ecologists and a percentage of systematists equal to that of the federal government, insect physiology is much more dominant in the university sector. The survey did not identify any university entomologists specializing in disease transmission by insects.

Table 3. Number of entomologists in each sub-discipline employed by each agency.

Sub-discipline	Federal Government	Provincial Government	Industry	Educational Institutions	Other	TOTAL
Apiculture	5	5	0	4	1	15
Applied Pest Control (Biological)	34	4	1	6	2	47
Applied Pest Control (Chemical)	24	15	15	5	1	60
Disease Transmission	6	4	0	0	0	10
Ecology	48	5	0	39	0	92
General	15	7	0	11	1	34
Morphology	2	0	0	5	0	7
Physiology	9	0	0	27	0	36
Systematics	31	3	1	14	0	49
Toxicology	11	1	0	3	0	15
Other	40	23	1	25	15	104
Total	225	67	18	139	20	469

(b) Age —

The average age of all entomologists is 44 years. There is a considerable difference in the age profile of entomoligists relative to employees. In the federal government, 63% are over 45, whereas only 40% of entomologists employed by industry, provincial governments and educational institutions are in this age group.

(c) Educational Background —

A majority of the professional entomologists in Canada have earned a Ph.D. (Table 4). This is the most frequent level of training of those employed by the federal government or by educational institutions. At the provincial government level, the Master's degree is more common. In industry, the largest percentage of employees have no formal training beyond the Bachelor's degree. Among female professional entomologists, 26% have not studied beyond the Bachelor's level.

Table 4. Percentage of entomologists at each educational level employed by major employers[1].

Highest Degree	PERCENTAGE					
	Total		Federal Government	Provincial Government	Industry	Educational Institutions
	Male	Female				
Diploma	2	7	2	7	11	2
B.Sc.	12	26	10	22	39	6
M.Sc.	22	12	20	42	24	12
Ph.D.	63	55	68	25	14	80
Other	1	0	0	4	12	0

[1] Total = 469; males 438, females 31.

Only 38% of Ph.D.'s employed in entomology in Canada earned their Ph.D. in this country (Table 5). An almost equal percentage earned their Ph.D. degrees in the United States, with most of the remainder obtaining their highest education in the United Kingdom. While the percentage of holders of Canadian Ph.D. degrees is essentially the same in the federal government and educational institutions, these two major employers differ widely in their preference for extra-Canadian degrees. The federal government employs more Ph.D.'s with U.S. degrees, than do educational institutions. The latter hire a higher percentage of entomologists that earned their Ph.D. in the United Kingdom.

Table 5. Origin of Ph.D. in each of the two main employment sectors.

Origin of Degree	Percentage		TOTAL
	Federal Government	Educational Institutions	
Canada	37	39	38
United States	48	26	39
United Kingdom	15	35	23

Total = 264.

(d) Support —

Most entomologists are in the $15,000.-$30,000. salary bracket; the average salary is $21,775. per annum (Table 6). Thirty-two entomologists earn less than $10,000. and 73 earn more than $30,000. The salary levels of federal and provincial government entomologists are almost reciprocal. Seventy-five per cent of the former, while only 27% of the latter earn more than $20,000. Educational institutions pay 60% of their entomologists more than $20,000. Differences in salary levels are related to age and educational qualifications rather than any significant differences in basic pay scales.

Table 6. Salary of entomologists in each of the major employment sectors.

Employer	Number Entomologists	Salary Range (thousands of dollars)						
		<10	10-15	15-20	20-25	25-30	>30	Not Known
Federal Government	225	4	15	36	71	57	42	0
Provincial Government	67	4	14	30	13	3	1	2
Industry	18	1	2	7	3	5	0	0
Educational Institutions	139	14	16	26	34	19	30	0
Other	20	9	3	2	1	0	0	5
Total	469	32	50	101	122	84	73	7

Twenty-five per cent of entomologists have two or more assistants, 36% have one, 18% share a technician and 20% have no technical assistance (Table 7). Staff support for entomologists would appear best in the federal government followed by industry, provincial government and educational institutions. It is obvious that support staff is related to the research function rather than to activities in extension or teaching.

Table 7. Staff support for entomologists in the major employment sectors.

Employer	Number of Entomologists	Number with indicated staff					
		0	<1	1	2	>2	Not Known
Federal Government	225	24	26	120	23	31	1
Provincial Government	67	17	13	15	4	14	4
Industry	18	2	4	3	4	5	0
Educational Institutions	139	39	36	31	19	13	1
Other	20	11	1	0	1	3	4
Total	469	93	80	169	51	66	10

(e) Retirement Plans —

Four hundred and forty-three entomologists indicated their retirement plans (Table 8). Of these, more than half intend to work until age 65.

Only 38% and 41% of entomologists employed by industry and the federal government, respectively, intend to work until age 65. This compares to 77% in educational institutions, and 57% in the provincial governments. While only 9% of those employed in educational institutions plan to retire at age 55 or less, expectations to retire at this age, in the provincial government, are held by 16%, in the federal government by 20%, and in industry by 28%.

Table 8. Number of entomologists planning to retire at indicated age in the major employment sectors.

Employer	Number Responding	Age of anticipated retirement			
		65	60	55	50
Federal Government	222	91	86	35	10
Provincial Government	62	35	17	5	5
Industry	18	7	6	3	2
Educational Institutions	131	101	19	6	5
Other	10	7	2	0	1
Total	443	241	130	49	23

Within sub-disciplines, a high percentage of morphologists and apiculturalists intend to work to age 65; whereas, the highest percentages of those planning to retire at age 55 or less, are found in the sub-disciplines of disease transmission, general entomology, systematics and toxicology. A high percentage of entomologists in Ontario and Quebec plan to continue working to age 65. The highest proportion of those planning to retire early (55 or younger) are to be found in Nova Scotia and Manitoba.

Entomologists employed in administration or research plan to retire earlier than teachers. Numbers planning to retire in the next five years and in the next decade relative to sub-discipline are displayed in Table 9.

Table 9. Entomologists, average age, and retirement plans in each sub-discipline.

Sub-discipline	Number Entomologists	Mean Age	Number planning to retire within: 5 years	10 years
Apiculture	15	51.0	4	6
Applied Pest Control (Biological)	46	45.5	7	17
Applied Pest Control (Chemical)	70	41.8	12	20
Disease Transmission	10	46.6	3	3
Ecology	95	42.3	8	17
General	34	46.4	11	15
Morphology	7	45.6	1	2
Physiology	37	40.4	1	4
Systematics	50	42.6	9	16
Toxicology	15	45.1	1	3
Other	77	42.0	10	28
Total	456		67	131

Graduate Students

Sixty-eight per cent of the graduate students replied to the questionnaire (Table 10). Seventy per cent of these are in six universities; 101 are male, 22 female, and 1 unspecified. Seventy-three are enrolled in Master's programs (62 male, 11 female) and 47 students (35 male, 12 female) are pursuing studies toward the Ph.D. Simon Fraser University has the largest number of graduate students (25) and in relation to the other universities, a much larger percentage in the Master's program. By contrast, at the University of Alberta, McGill University and the University of Toronto, the majority are pursuing programs toward the Ph.D. Almost half of all graduate students are pursuing programs in two areas: pest control (biological), and insect ecology (Table 11). Systematics, pest control (chemical), general entomology, and physiology are the next most popular sub-disciplines. A large percentage of the students will complete their programs and be available for employment in 1976 (Table 12).

Table 10. Universities in Canada with five or more graduate students in entomology.

University	No. of students in each program			
	M.Sc.	Ph.D.	Not Known	TOTAL
Macdonald College	6	3	1	10
McGill University	1	4	0	5
Simon Fraser University	20	5	0	25
University of Alberta	5	6	0	11
University of British Columbia	9	7	0	16
University of Guelph	9	5	0	14
University of Manitoba	6	5	0	11
University of Toronto	3	4	0	7
Other	14	8	3	25
Total	73	47	4	124

Their choice for employment in terms of function indicates that their first choice matches well with the percentage of entomologists in the current work force employed in these functions (Table 13). Seventy per cent of students indicated research or teaching as their first choice, a percentage very close to the 69% in these two functions in the current work force.

Table 11. Number of graduate students in each sub-discipline in entomology in each program.

Sub-discipline	No. of students in each program			
	M.Sc.	Ph.D.	Not Known	TOTAL
Apiculture	3	1	0	4
Applied Pest Control (biological)	24	6	1	31
Applied Pest Control (chemical)	6	3	0	9
Disease Transmission	0	2	0	2
Ecology	14	11	1	26
General	6	2	1	9
Morphology	1	1	1	3
Physiology	1	7	0	8
Systematics	6	5	0	11
Toxicology	2	2	0	4
Other	10	7	0	17
Total	73	47	4	124

Table 12. Number of graduate students in each sub-discipline in entomology seeking employment in the year indicated.

Sub-discipline	Year available '75	'76	'77
Apiculture	0	2	2
Applied Pest Control (biological)	6	18	2
Applied Pest Control (chemical)	1	6	1
Disease Transmission	0	1	0
Ecology	2	16	6
General	0	1	4
Morphology	1	1	1
Physiology	2	3	2
Systematics	0	5	2
Toxicology	1	1	2
Other	1	7	5
Total	14	61	27

Table 13. Percentage of students indicating their choices for work function and percentage of current work force in entomology employed in each function.

Function	Student choice (%) 1st	2nd	3rd	Current employment (%)
Administration	1	2	5	11
Extension	9	6	11	6
Consulting	6	10	15	3
Survey	3	8	17	3
Research	51	23	3	49
Teaching	19	31	12	20
Technical Development	1	5	8	2
Sales	0	0	0	0
Pest Control Operators	6	7	14	2
Regulatory	0	2	2	1
Other	4	6	13	3

The Demand for Entomologists

The demand for entomologists in Canada was assessed by a questionnaire to employers enquiring of their current work force in entomology and their perceived needs for the future. They were asked to indicate these needs in terms of two years, five years and ten years hence. They were asked, also, to predict either retrenchment or enlargement of their entomological work force and to indicate why. Eighty questionnaires were distributed and 57 returned (Table14). Five respondents failed to provide the information requested. Thus the sample consisted of 52 returns and accounted for 60% of the working entomologists in Canada.

Data on new requirements for entomologists indicate 66 new positions by 1985 (Table 15). In the federal government, both senior officials and Research Directors foresee increased demand. They disagree, however, on numbers. Research Directors project 34 new positions, while senior officials see a need for only 11. "Individual analysis of senior official questionnaires shows that their conservative estimates are based on a belief that the recommendations of the Lamontagne Report concerning the transfer of research capabilities from federal to industrial aegis will indeed be implemented, while field managers are more probably reflecting the *needs* of their respective programs as they see them, without regard to the political probabilities concerning the future locus of scientific effort." (Consultants' Report).

Table 14. Sources of information on demand for entomologists in Canada and extent of such sources.

Source Contacted	Number of questionnaires	
	Sent	Returned
Senior Officials (Fed. Govt.)	9	7
Research Directors (Agric. Canada)	17	14
Research Directors (Envir. Canada)	7	5
Provincial Government	6	3
Universities	23	17
Industry	11	6
Other	7	5
Total	80	57

In Table 15, an attempt is made to rationalize the differences between predictions of senior officials and predictions of research directors and this is presented in the column "Adjusted Demand". In arriving at these figures for "Adjusted Demand", we have used the estimates of research directors, since they are most conversant with pressing needs in their areas. In some instances (applied control (biological) and ecology), the differences are more apparent than real in that senior officials included 11 new positions under the category of "Other". In this category, they included 10 new positions in the area of integrated control. Since integrated control involves applied control and ecology, the differences in estimates become less pronounced.

Thus the most optimistic projection that can be made for additional requirements for entomologists in the next ten years is that 66 new positions will be created. Included in this projection, is that by universities for eighteen new positions. This seems unrealistically high in view of the projected need for students in entomology as discussed later.

Table 15. Projected increased demand for entomologists, 1975-85, as indicated by sources identified and adjusted demand in each sub-discipline.

Sub-discipline	No. additional entomologists indicated by source: Senior Officials (Fed. Govt.)	Research Directors (Ag. Can.)	Research Directors (Env. Can.)	Provincial Govt.	Universities	Industry	Other	Adjusted Demand
Apiculture	0	2	0	0	-1	0	0	1
Applied Pest Control (Chemical)	7	6	0	0	0	3	0	9
Applied Pest Control (Biological)	- 6	9	2	4	5	0	0	20
Disease Transmission	3	1	1	4	3	0	0	9
Ecology	-11	3	0	0	4	0	0	7
General	0	0	0	0	1	0	0	1
Morphology	0	0	0	0	1	0	0	1
Physiology	1	1	0	0	0	0	0	1
Systematics	0	1	1	0	3	0	3	8
Toxicology	6	3	0	0	1	0	0	4
Other	11	4	0	0	1	0	0	5
Total	11	30	4	8	18	3	3	66

Demand for Entomologists Versus Supply

The survey data permit an assessment of job opportunities for graduating students. They also indicate if employers will find students trained in the areas in which they seek expertise. In developing this information (Table 16), an assumption is made that the number of graduate students entering the job market in 1976 represents a normal output of graduate students at current program levels. Projected job openings consist of two components:

1. Retirement plans (Table 9) during the next five years in each of the sub-disciplines

and

2. The "Adjusted Demand" (Table 15) based on the employer's projections of new positions required

The data indicate that Canadian universities have an annual output of 61 graduate students who will compete for 20 job openings, a ratio of three students to one job. Perhaps more significant is the fact that in the sub-disciplines of pest control (biological), ecology, and physiology, the ratio of students to job opportunities exceeds five to one.

The employers were asked to indicate, based on their recent experience in recruitment, the availability of suitably qualified candidates in each of the sub-disciplines. Their responses plus the supply/demand data would indicate the following:

Table 16. Annual output of graduate students in Canada, and employment opportunities based on retirements and projected new positions.

Sub-discipline	No. Students Current Output	No. of Openings through: Retirements	New Positions	Total Demand
Apiculture	2	0.8	0.1	0.9
Applied Pest Control (Biological)	18	1.4	2.0	3.4
Applied Pest Control (Chemical)	6	2.4	0.9	3.3
Disease Transmission	1	0.6	0.9	1.5
Ecology	16	1.6	0.7	2.3
General	1	2.2	0.1	2.3
Morphology	1	0.2	0.1	0.3
Physiology	3	0.2	0.1	0.3
Systematics	5	1.8	0.8	2.6
Toxicology	1	0.2	0.4	0.6
Other	5	2.0	0.5	2.5
Unknown	2	-	-	-
Total	61	13.4	6.6	20.0

1. Apiculture —

The projected demand for the next ten years is 7. Four students are currently enrolled in Apiculture programs. Of these, three are foreign nationals who will return to their home countries. Thus the supply/demand situation with respect to this specialty may be in reasonable balance.

2. Applied Pest Control (Biological) —

It is projected that there will be 37 openings in this field during the next ten years. With 18 students coming on the market in this area in 1976 alone, it is obvious that training programs in this area are over-subscribed.

3. Applied Pest Control (Chemical) —

During the next ten years, there will be 20 retirements in this area and a projected additional demand for 9, making a total demand of 29 in the next ten years. Six students in this specialty will be available for employment in 1976. Although these figures suggest a reasonable balance between supply and demand, it should be pointed out that 14 of the 24 entomologists in this sub-discipline in the federal service will retire in the next 10 years, 9 in the next 5. If normal recruitment patterns of the federal service pertain, replacements will be at the Ph.D. level. If this is so, there will be a critical shortage of Canadian-trained Ph.D.'s in this area.

4. Disease Transmission —

The projected need in this sub-discipline over the next ten years is 12. This is made up of 3 retirements plus a projected demand for 9 new people. Only one student with this specialization will be available for employment in 1976. On this basis, it would appear that the supply/demand situation may be quite critical.

5. Ecology —

There will be 17 retirements in the field of ecology in the next ten years and a projected demand for 7 additional people, or a total demand for 24. Sixteen students will be seeking employment in this specialty in 1976 alone. It is apparent that this area of graduate study is currently over-subscribed in Canada.

6. General Entomology —

Of those who consider themselves general entomologists, 15 will retire during the next ten years (11 in the next five) and there is a projected need for one additional person in this area. Only 1 student indicated his field as general entomology, which, on the surface, suggests a shortage of supply. The job specifications for a general entomologist, however, can be met usually by a student in one of the more specialized sub-disciplines (ecology, applied control (biological), applied control (chemical)). Thus the apparent shortage should not present a real problem.

7. Morphology —

There is an apparent need for three morphologists over the next ten years and one student will be available in 1976.

8. Physiology —

Twenty employers identified this sub-discipline as a low demand/high supply specialty. Only four physiologists of a total of 37 will retire in the ten years and only 1 in the next five. There is a projected need for one additional person in this area. Three insect physiologists will be on the job market in 1976 and there are currently 8 students in this specialty in Canadian universities. It would appear that this discipline is over-subscribed.

9. Systematics —

Sixteen systematists will retire in the next ten years and employers indicate a further requirement of 8 for a total of 24. Five students will complete their programs in this specialty in 1976.

10. Toxicology —

Three toxicologists will retire in the next ten years and employers predict a demand for an additional 4 for a total of 7. Only one graduate student in toxicology will be available in 1976 with two additional students indicating completion of their program in 1977.

Discussion

The consultants' report on entomological manpower in Canada contains a great deal of information not covered in this paper. Four hundred and sixty-nine entomologists responded to the questionnaire and this represents well over 80% of the professional entomologists currently employed in Canada. In summarizing their report, the consultants emphasize three main points:

1. An imbalance between the projected supply of graduate students and the demand for their services
2. A pessimistic attitude among entomologists and their employers
3. Lack of planning on the part of the federal government.

During the next ten years there will be approximately 200 vacancies for students with advanced training in entomology. Current graduate training levels would indicate that during this same period, approximately 600 students will be available for these openings. In addition, this apparent surplus of graduates in entomology from Canadian universities is compounded by current immigration policy. Numerous graduate entomologists from other countries are emigrating to Canada even though job openings in entomology are scarce. While it is recognized that students with graduate training in entomology find employment in a variety of sectors outside their chosen profession, it seems irrational for Canada to continue graduate programs in this discipline at the levels now in vogue.

With regard to the supply/demand situation, the consultants draw the following conclusions:

(a) "Dollars are currently being spent to educate students in fields where they are not needed"

(b) "As it takes five years to produce a Ph.D. entomologist, there is an immediate need to rectify the lack of communication between the suppliers of entomological skills (the universities) and the major users (federal and provincial agencies and industry) to rationalize the anomalies in the present supply/demand situation"

(c) "It is imperative that major employers develop and/or clarify their scientific policies, programs and objectives to provide guidance to the universities"

Although we concur, in part, with the conclusions of the consultants with respect to the oversupply of graduate students, the following points should be made:

If one analyzes the projected vacancies, it will be noted that, in the next ten years, the majority of retirements will involve entomologists employed by the federal government whose primary function is research. In addition, universities indicate an increased demand for entomologists in their teaching programs. Assuming that federal hiring policies and those of the universities remain the same, recruitment will be at the Ph.D. level. In addition, if one conpares the ratio of Master's to Ph.D. candidates in the graduate stream against training levels in the current work force, it is apparent that enrolment in Ph.D. programs will have to increase to supply the

anticipated demand. If this is true, then the number of Ph.D. candidates available for the projected openings may be short of the requirement. Assuming a five-year training program for a Ph.D. student, the current enrolment of graduate students would suggest an output of approximately 25 students a year, a figure quite close to the 20 vacancies per year projected. Indeed, in some disciplines which have been identified as areas where demand will exceed supply, example: applied pest control (chemical), graduate training is primarily at the Master's level. In such instances, universities would be well advised to expand graduate training programs to ensure that supply will equal demand.

Within the field of entomology, training programs at the sub-disciplinary level are badly out of balance with relative demands in these sub-disciplines. While it is recognized that some of the sub-disciplines indicated embrace a sufficient diversity of training that graduates could accept employment in related fields, it is important that efforts be made to bring supply in the various sub-disciplines of entomology into closer relationship with projected demand. Faculty at universities should be cognizant of these facts and ensure that students entering graduate programs in entomology are appraised of the employment situation and encouraged to pursue a broad training in entomology.

The consultants' second main point deals with pessismistic attitude among entomologists and their employers. The consultants comment as follows:
"A general aura of pessimism exists among practising entomologists, both bench scientists and managers toward what they regard as an "anti-science" posture on the part of the federal government. Our conclusion, here, is based largely on the predictive responses to the Management Questionnaire and gratuitous comments attached to the Supply Survey. This feeling appears to stem from a perceived shrinkage in the total scientific community and a belief that the entomological community is shrinking at an even faster rate."
Agriculture Canada, the largest single employer within the federal government, was considered to be "anti-entomologist". The consultants continue:
"This lack of morale seems to be felt most by entomologists employed with the federal government, if the fact that approximately 60% of these plan early retirement is any indication of their esprit-de-corps."

It may be argued that the high percentage of federal government entomologists planning early retirement is related, primarily, to generous superannuation benefits rather than low morale. Based on comments received in the survey and our general knowledge of the situation, we would suggest that low morale is the major factor leading to early retirement. Few scientists in the federal government would elect early retirement if the attitude toward scientific research was favourable, excellence encouraged and bureaucracy reduced. Many respondents indicated little confidence in federal government "science policy" and were severely critical of lack of long-range planning. Lack of the latter was evident from the responses of senior officials in the federal service versus directors of research establishments. On this subject, the consultants comment as follows:
"Within the federal government, there appears to be a fairly significant discrepancy regarding the future need for entomologists as seen by senior management and as seen by managers in the field. Of the group responding to the employment questionnaire, senior officials predict, on balance, the need for only 11 new entomological positions during the next ten years, while field managers are calling for 34 new jobs. In part, and judging from comments made by the respondents, this seems to reflect,

on the one hand, the perceived *need* (i.e., the field manager responses) and what is politically *viable* (i.e., what is perceived as likely to happen, as perceived by senior officials more intimately connected to the policy-making function). Again, the situation shows need for greater clarification of the actual direction of federal government science policy so that appropriate decisions at the operating level can be made. It should be kept in mind, however, that the response from senior officials to this survey was quite low and . . . based on their belief in the serious intent of the federal government to pursue the Lamontagne recommendations with respect to the transfer of research capabilities to the industrial sector."

With regard to the latter point, it is quite evident from the data obtained in the survey that the industrial sector has little intention of developing research capability for pest control in Canada over the next ten years. Only five industrial concerns responded to the employment questionnaire and predicted only three new vacancies for entomologists in that period. It would appear that despite the Lamontage report, industry is awaiting positive indication of federal government action with regard to its stated policy of buying of research under contract from industry.

The data obtained in the survey also negated the widely held belief that as the federal government de-emphasizes research, provincial agencies will assume such responsibility. The latter projected only 8 new positions over the next decade: four positions in biological control and four in disease transmission. We need not underline the fact that this scarcely represents a capability in pest control for the future.

Although entomologists generally feel that there is a lack of understanding and support on the part of the federal government, its agencies and the public at large for their services, the consultants also point out that there is some optimism. "From the more positive comments . . . entomologists appear acutely aware of their mission and feel that both the Canadian public and the federal government must ultimately become similarly informed. They cite the need for insect survey; to aid the habitation of the north; to improve the harvests, and a demand for . . . faunistic studies . . . They believe the demand (for management of biting flies, for producing an ecologically sound environment and for improving physical health) will require toxicologists, ecologists and disease transmission specialists. Finally, they feel that public demand . . . will generate a need for more sophisticated pest management . . ."

The consultants continue:
"However, some respondents note, cynically, that none of this is likely to occur until panic sets in which may lead to indiscriminate hiring practices at the subdisciplinary level, thus amplifying the modes and troughs of what appears to constitute a sporadic employment pattern."

In reviewing the consultants' report, we were surprised to learn that despite the fact that chemical control of insect pests is now, and will continue to be, the main method of protecting food and fibre, the proportion of entomologists in the applied control (chemical) category is small, only 24 in the federal service. Projections by employers would appear to recognize, in part, this absolute and relative shortage, but such recognition is not reflected in graduate student interests. Unless the situation is corrected soon, it would appear that our knowledge on chemical control of pests is likely to continue to fall behind Canadian needs.

We can only emphasize that if Canada is to maintain its position as a major producer of food and fibre, protect human health, develop the north and create an ecologically sound environment, there is an immediate and continuing need for effective long-term science policy. The trend toward reduced numbers of entomologists employed in Canada must be reversed, and soon.

Reference

Manpower Study of Professional Entomologists in Canada. Potentia Consultants Ltd., 1976. (Copy available on loan from the Secretary, Entomological Society of Canada.)