

HUMAN RESOURCES IN ENTOMOLOGY IN CANADA

Current Status (1983) and Future Projections

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ABSTRACT

A survey of entomological personnel in Canada was conducted by the Entomological Society of Canada in 1983. The objectives were to review predictions made in 1975; to examine any changes in supply and demand resulting from the implementation of recommendations put forth in 1975; and to project changes in the human resources in entomology in Canada for the next 5 years. Questionnaires were sent to entomologists, graduate students in entomology, and employers of entomologists in Canada.

Five hundred professional entomologists responded to the questionnaire. The number, geographical location, and educational level of entomologists were essentially unchanged since 1975. The average age of respondents had declined by one year to 42.7 years. As in 1975, the largest number of entomologists was employed by the federal government (43%), followed by educational institutions (36%), provincial governments (14%), and industry (6%). Increases were apparent in educational institutions and industry while a decline was evident in the federal government. Over half of the entomologists held doctoral degrees (61%) and there was little change in the proportion employed by each employer group at a given level of education. The primary functions of entomologists remained the same with most in research (63%), teaching (10%), administration (7%), and extension (6%). The number of entomologists in administration and teaching decreased while the number in research increased. Most entomologists worked in specializations of ecology (23%), forest entomology (15%), applied pest control — biological (13%), and chemical (13%), or systematics (9%). Entomologists had a higher number of support staff and higher salaries in 1983 than in 1975. Sixty percent of entomologists plan to retire at age 65. The proportion of female entomologists in the work force increased from 7.0% in 1975 to 11.1% in 1983. This trend will continue as almost one-third of all graduate students are female.

One hundred sixty-three graduate students responded to the questionnaire. Of these, 60% were in M.Sc. programs and 40% in Ph.D. programs. Entomology graduate students attended 24 different universities in 1983 compared with 15 in 1975. Over 75% of the graduate students were at 9 Canadian universities. The most popular sub-disciplines in decreasing order were: ecology, applied pest control — biological, systematics, and forest entomology. The preferred function of graduate students was research. On the basis of expected retirements, some specializations were undersupplied (i.e., applied pest control — chemical and toxicology), while others were oversupplied (i.e., applied pest control — biological, ecology and forest entomology).

From this study it was concluded: a) there were no major changes in the overall human resources situation for entomologists in Canada between 1975 and 1983 and no major changes are expected in the next 5 years; b) a shift in priorities has occurred at educational institutions from teaching to research; c) there remains an imbalance between the projected supply of graduate students and the demand for their services.

INTRODUCTION

In 1975, the Entomological Society of Canada conducted a survey of the entomological manpower in Canada. The results were summarized in the *Bulletin of the Entomological Society of Canada*, Vol. 8(3). Three major conclusions were reached:

1. "A grave imbalance was present between the predicted supply and demand for entomologists; the supply would outstrip the demand by three to one until the mid-1980's;

2. Supply and demand problems would be more severe in some sub-disciplines than in others;
3. Pessimism existed amongst entomologists as to the future of entomology in Canada due to a lack of long-term planning by the federal government."

It was obvious from these findings that substantial amounts of money were being spent to educate students, at a cost of ca. 100 thousand dollars per student, in fields where they were not needed. There was an immediate need to improve communication between producers and employers of entomologists so that the emphasis on entomological training might reflect society's need. In addition, it was apparent that there was a need for government to develop and clarify scientific policies, programs, and objectives enabling universities to train entomologists in areas where they could find jobs.

To review the accuracy of the 1975 predictions and project trends for the next 5 years, the Entomological Society of Canada conducted a survey of human resources in entomology in 1983. The primary objectives of this survey were to:

1. Determine if the 1975 survey accurately predicted the human resources situation in entomology in Canada since that time;
2. Determine if the problems of oversupply in certain sub-disciplines and undersupply in others have been corrected due to implementation of recommendations of the 1975 survey;
3. Assess the human resources situation in entomology in Canada for the next 5 years.

The study was supported by Agriculture Canada through Supply and Services Canada and was completed in January, 1984. This report summarizes the major findings of the study, but omits much of the information collected. Those interested in detailed information may obtain a copy of the full report from the Society.¹

METHODOLOGY AND DATA SOURCES

The study was conducted by the Entomological Society of Canada by the four members of the 1983 Employment Committee: D. J. Madder, G. B. Kinoshita, S. M. Smith, and R. S. MacDonald. The work was guided by a Scientific Committee (F. L. McEwen, C. R. Harris, H. J. Herbert, and D. J. Madder) who assisted in designing the survey and reviewing the report of the Study Team. The primary data sources were comprised of two sets of questionnaires; one sent to professional entomologists, the other to entomology students. Mailing lists were compiled from membership lists of the Entomological Society of Canada, the seven regional societies in Canada, the Entomological Society of America, and the Biological Survey of Insects in Canada. Six hundred thirty-two professional entomologists (58%) responded. Of these, only 500 were pertinent as 132 were returned from amateurs, people who had changed professions, or retired entomologists, and 17 were returned after the analyses were completed. One hundred sixty-three graduate students responded with 138 pertinent to the study. All information from professionals and students was coded, entered into an Amdahl main-frame computer and the data processed using SPSS.² A third set of questionnaires was distributed to 146 managers (employers) of entomologists across Canada, however, returns from this group were not sufficient to provide valid data.

Two assumptions were made in analyzing the data: 1) the sampling methods used provided data that were representative of the entire professional and student entomological community (this may not be true as the sampling method was based, with no viable alternative, on membership in an entomological society), and 2) the data collected were comparable to that of the 1975 survey (this is believed to be true with one exception noted in the text).

PROFESSIONAL ENTOMOLOGISTS

(a) *Current Employment*

As in 1975, the largest number of entomologists work in Ontario, followed by Quebec, British Columbia, Alberta and Manitoba (Table 1). The largest number of entomologists was

employed by the federal government, followed by educational institutions, provincial governments and industry. The number of entomologists responding from the federal government declined in most provinces while increases were evident at educational institutions and industry. The number of entomologists working with provincial governments remained almost unchanged. Ontario had the largest number of entomologists working for the federal government, educational institutions and industry, whereas Quebec had the largest number working for a provincial government.

Table 1. Entomologists employed in each province by employer in 1983.

Province	Federal Government	Provincial Government	Industry	Educational Institutions	Total
BC	29 (- 3)*	10 (+2)	4 (+2)	18 (- 1)	61 (0)
Alberta	17 (- 5)	11 (-4)	2 (+2)	21 (+10)	51 (+ 3)
Saskatchewan	15 (- 6)	3 (-5)	3 (+3)	3 (- 4)	24 (-12)
Manitoba	24 (+ 1)	5 (+1)	5 (+4)	9 (0)	43 (+ 6)
Ontario	71 (-10)	10 (+7)	12 (+2)	62 (+10)	155 (+ 9)
Quebec	15 (0)	18 (+1)	1 (-1)	35 (+12)	69 (+12)
Prince Edward Island	1 (- 1)	0 (0)	0 (0)	1 (- 1)	2 (- 2)
New Brunswick	14 (+ 1)	3 (0)	0 (0)	7 (+ 3)	24 (+ 4)
Nova Scotia	6 (- 3)	4 (-3)	1 (0)	1 (- 5)	12 (-11)
Newfoundland	3 (- 3)	1 (-1)	0 (0)	7 (+ 4)	11 (0)
TOTAL	195 (-29)	65 (-2)	28 (+12)	164 (+28)	452 (+ 9)

*Net change in number of entomologists employed for each category between 1975 and 1983 in parentheses.

As in 1975, the majority of entomologists indicated either research (63%) or teaching (10%) as their main function (Table 2). At educational institutions, however, there was a distinct shift in the primary function of entomologists from teaching in 1975 to research in 1983. The number of entomologists employed in an administrative function declined. Many entomologists, however, were still engaged in a number of functions apart from their primary responsibility, particularly those in educational institutions, provincial governments, and industry. There was a substantial increase in the number of entomologists who cited the function category "Other". Most of these entomologists did not work for the four major employers. They were self-employed (21), working at museums (4), or working overseas (13).

The number and proportion of entomologists in each specialization followed the same trends as in 1975 (Table 3). Most entomologists identified their specialization as insect ecology (103), followed by forest entomology (see note at bottom of Table 3), applied pest control — biological, applied pest control — chemical, systematics, and physiology. There was a significant decline in the number of entomologists employed as physiologists while increases were evident in applied pest control — biological, ecology, and morphology. The apparent decline in applied pest control — chemical, is primarily associated with the use of the new categories of forest entomology and plant protection.

Ecologists were employed, primarily, by the federal government and educational institutions. Forest entomologists and those in applied pest control — biological, were employed by both levels of government and educational institutions. Although all agencies employed entomologists working in applied pest control — chemical, fewer were found at educational institutions. Systematists were hired primarily by educational institutions and the federal government, whereas the educational institutions were the major employers of morphologist and physiologists.

(b) Age

The average age of all entomologists declined between 1975 and 1983 from 44.0 to 42.7 years. The average age of entomologists working for each employer in 1983 was: federal government 45.5, provincial government 31.6, industry 39.7, and educational institution 42.4.

(c) Educational Background

Most entomologists (61%) responding to the survey held a doctorate degree and the majority of these were employed by educational institutions or the federal government (Table

Table 2. Primary functions of entomologists by employer.

Function	Federal Government	Provincial Government	Industry	Educational Institutions	Total
Administration	9 (- 7)*	7 (-8)	5 (-2)	9 (- 1)	30 (-18)
Extension	5 (- 3)	18 (0)	2 (+2)	3 (+ 1)	28 (0)
Consulting	1 (- 7)	4 (+2)	1 (-1)	0 (0)	6 (- 6)
Survey	9 (+ 4)	3 (-1)	0 (-1)	0 (0)	12 (+ 2)
Pest Control Operators	4 (+ 1)	6 (+2)	1 (0)	0 (0)	11 (+ 3)
Regulatory	4 (+ 3)	5 (0)	2 (+2)	0 (0)	11 (+ 5)
Research	158 (-19)	15 (+6)	7 (+7)	103 (+64)	283 (+58)
Teaching	2 (+ 1)	1 (-3)	0 (0)	43 (-43)	46 (-45)
Technical Development	0 (- 1)	2 (+1)	8 (+1)	1 (- 1)	11 (0)
Sales	0 (0)	0 (0)	1 (+1)	0 (0)	1 (+ 1)
Other	2 (- 3)	4 (+1)	1 (+1)	4 (+ 4)	11 (+ 3)

*Net change in number of entomologists employed for each category between 1975 and 1983 in parentheses.

Table 3. Number of entomologists in each specialization with each employer in 1983.

Specialization	Federal Government	Provincial Government	Industry	Educational Institutions	Total
Apiculture	3 (- 2)*	6 (+ 1)	0 (0)	6 (+ 2)	15 (+ 1)
Applied Pest Control Biological	35 (+ 1)	7 (+ 3)	1 (0)	14 (+ 8)	57 (+12)
Applied Pest Control Chemical	17 (- 7)	16 (- 9)	17 (+2)	6 (+ 1)	56 (-13)
Ecology	49 (+ 1)	3 (- 2)	3 (+3)	48 (+ 9)	103 (+11)
General***	0 (-15)	0 (- 7)	0 (0)	6 (- 5)	6 (-27)
Morphology	3 (+ 1)	1 (+ 1)	0 (0)	10 (+ 5)	14 (+ 7)
Physiology	3 (- 6)	0 (0)	0 (0)	22 (- 5)	25 (-11)
Systematics	17 (-14)	2 (- 1)	0 (-1)	22 (+ 8)	41 (- 8)
Toxicology	7 (- 4)	2 (+ 1)	0 (0)	3 (0)	12 (- 3)
Forest Entomology**	39 (+39)	15 (+15)	1 (+1)	10 (+10)	65 (+65)
Plant Protection**	2 (+ 2)	8 (+ 8)	2 (+2)	1 (+ 1)	13 (+13)
Other**	18 (-18)	4 (-11)	1 (0)	14 (- 7)	37 (-36)

* Net change in number of entomologists employed for each category between 1975 and 1983 in parentheses.

** Categories of Forest Entomology and Plant Protection were not included in 1975. Gains in these areas probably reflect losses from the categories of applied pest control — chemical and "Other."

***Losses in this category may be due to more specific assignments in other categories.

Table 4. Percentage of entomologists at each educational level by employer in 1983.

Degree	Percentage of Entomologists				
	Federal Government	Provincial Government	Industry	Educational Institutions	Total
Diploma	4 (+1)*	9 (+4)	4 (- 8)	0 (-1)	3 (0)
B.Sc.	10 (0)	20 (-3)	30 (-11)	8 (+1)	13 (0)
M.Sc.	18 (-1)	48 (+6)	41 (+12)	12 (0)	23 (+1)
Ph.D.	69 (0)	23 (-7)	26 (+ 8)	80 (-1)	61 (-2)

*Net change in percentage of entomologists employed for each category between 1975 and 1983 in parentheses.

4). There was very little change in the proportion of entomologists employed by the federal government or educational institutions at a given level of education. The provincial government, however, showed an increase in the proportion of entomologists with master's degrees, while there was a general trend in industry to hire entomologists with higher degrees. Generally, plant protection, applied pest control — chemical, and apiculture had the lowest proportion of entomologists with doctorates, while physiology, ecology, toxicology, systematics, and morphology had the highest.

Each employer, with the exception of industry, showed increases in the number of entomologists who had obtained their Ph.D. from Canadian institutions (Table 5). The provincial government, in particular, had a high proportion of entomologists with Canadian doctorates. There has been a general decline in the employment of entomologists with doctorates from Britain or the United States while the number of entomologists with doctorates from the "Other" category increased. These changes may be due to the retirement of those entomologists hired during the late 1940's and early 1950's, many of whom received their doctorates in the United States or Britain.

(d) *Support*

There was a decline in the number of entomologists with 1 or less support staff while the number of entomologists supervising 2 or more support staff increased (Table 6). The lowest number of support staff were associated with physiologists and morphologists, while the highest with those in general entomology, forest entomology, plant protection, or ecology.

Entomologists with higher degrees received higher salaries (Table 7). The overall mode for entomologists with diplomas being \$25,000 - \$30,000; B.Sc. \$25,000 - \$30,000; M.Sc. \$30,000 - \$35,000; and Ph.D. > \$40,000. Salaries within educational levels increased with the age of the entomologists. The highest paid functions were administration followed by research and teaching, while the lowest paid functions were sales, regulatory, or pest control.

Table 5. Origin of Ph.D. employed by each agency in 1983.

Origin of Degree	Percentage of Entomologists				
	Federal Government (N = 136)	Provincial Government (N = 14)	Industry (N = 7)	Educational Institutions (N = 131)	Total (N = 288)
Canada	49 (+12)*	71 (+21)	29 (+29)	48 (+10)	50 (+11)
United States	36 (-11)	29 (- 1)	57 (-10)	25 (- 2)	32 (- 5)
Britain	12 (- 3)	0 (-20)	14 (-19)	15 (-20)	13 (-10)
Other	3 (+ 2)	0 (0)	0 (0)	12 (+12)	6 (+ 5)

*Net change in percentage of entomologists employed for each category between 1975 and 1983 in parenthesis.

Table 6. Staff support for entomologists by employer in 1983.

Number of Staff	Federal Government	Provincial Government	Industry	Educational Institutions	Total
0	19 (- 5)*	7 (-10)	3 (+1)	21 (-18)	50 (-32)
1	89 (-57)	16 (-12)	8 (+1)	51 (-16)	164 (-89)
2	34 (+11)	7 (+ 3)	1 (-3)	23 (+ 4)	65 (+15)
+3	28 (- 3)	19 (+ 5)	8 (+3)	32 (+19)	187 (+24)

*Net change in number of entomologists employed for each category between 1975 and 1983 in parentheses.

Table 7. Salary of entomologists by degree of education in 1983.

Degree of Education	Salary Range (\$1,000.)							Total
	15	15-20	20-25	25-30	30-35	35-40	40	
Diploma	1	1	3	6*	1	4	14	
B.Sc.	5	2	13	9*	9	9	6	53
M.Sc.	8	3	12	17	14*	12	30	96
Ph.D.	4	5	12	24	31	33	174*	283

*Represents mode of each group. The mode was used in analysis since a breakdown of salary in excess of \$40,000. was not included and a significant proportion of entomologists were within this range.

Table 8. Number of entomologists planning to retire at indicated age by employer in 1983.

Age of Retirement	Federal Government	Provincial Government	Industry	Educational Institutions	Total
65+	96 (+ 5)*	28 (-7)	16 (+9)	108 (+7)	248 (+14)
60	70 (-16)	20 (+3)	9 (+3)	25 (+6)	124 (- 4)
55	13 (-12)	9 (+4)	1 (-2)	8 (+2)	31 (- 8)
50	5 (- 5)	3 (-2)	0 (-2)	1 (-4)	9 (-13)

*Net change in number of entomologists employed for each category between 1975 and 1983 in parentheses.

Table 9. Number of entomologists planning to retire at each age by specialization in 1983.

Specialization	Age of Retirement				Total
	65	60	55	50	
Apiculture	7	2	2	0	11
Applied Pest Control					
— Biological	28	22	6	3	59
Applied Pest Control					
— Chemical	23	25	6	0	52
Ecology	65	30	3	1	99
General	2	2	1	0	5
Morphology	6	3	2	1	12
Physiology	17	5	0	0	22
Systematics	33	5	3	1	42
Toxicology	8	3	0	1	12
Forest Entomology	36	20	3	4	63
Plant Protection	10	2	1	1	14
Other	19	11	4	2	36

(e) Retirement Plans

More than half of all entomologists plan to retire at age 65 or later (Table 8). Only slight changes were evident since 1975 with a small increase in the proportion planning to remain at work until age 65. Entomologists employed by educational institutions had the highest proportion of those planning to remain to age 65, followed by industry, the federal government, and the provincial government. Based on geographical location, more than 60% of entomologists plan to remain until age 65 in P.E.I., Ontario, New Brunswick, and Quebec. The

highest proportion of those planning to retire before 65 were in Saskatchewan and Nova Scotia.

Entomologists employed as systematists, physiologists, and those in plant protection plan late retirement (Table 9), while those involved in general entomology and applied pest control — biological and chemical, plan relatively early retirements. Generally, entomologists with doctorate degrees plan a later retirement than those with other degrees. As in 1975, entomologists employed in administration, or extension plan to retire earlier than those in research or teaching.

(f) *Female Entomologists*

Of the 500 respondents in 1983, 55 (11%) were female, an increase of 4% since 1975. Ontario had the largest number of women entomologists followed by British Columbia and Manitoba. Substantial increases occurred in the number of women entomologists employed in Ontario, Manitoba, and British Columbia, while declines were evident in Nova Scotia and Quebec. Educational institutions employed the greatest proportion of women followed by the federal government. The federal government employed a lower proportion of women in relation to its total entomology work force, whereas most provincial governments employed a relatively high proportion of women.

Generally, female entomologists were younger than average (\bar{x} = 35 years) and were not found in administrative positions. Women had less support staff than their male counterparts and received lower salaries. This may be a function of both education (relatively few held doctorates) and age (most were relatively young). The education level of women entomologists, in comparison to men, showed a relatively low proportion of Ph.D.'s and a high proportion of other degrees. Since 1975, the proportion of female entomologists with M.Sc. degrees has increased significantly while the proportion with Ph.D.'s has decreased.

A greater number of women entomologists were involved in applied pest control — biological, and physiology while comparatively few worked in the areas of applied pest control — chemical, and ecology. In addition, proportionally fewer female entomologists were engaged in teaching while the proportion engaged in extension was greater than average.

GRADUATE STUDENTS

In 1983, entomology graduate students attended 24 different universities in Canada, as well as several foreign universities, compared to 15 in 1975. This increase in diversity was primarily at the master's level. Simon Fraser University still has the largest number of graduate students (22) although substantial increases were evident at Laval University and the University of Guelph (Table 10).

Table 10. Universities with four or more Canadian graduate students in entomology in 1983.

University	Number of Students in Each Program			
	B.Sc.*	M.Sc.	Ph.D.	Total
Simon Fraser University	1	15 (-5)**	6 (+1)	22 (- 3)
University of British Columbia	0	8 (-1)	6 (-1)	14 (- 2)
University of Alberta	0	4 (-1)	2 (-4)	6 (- 5)
University of Saskatchewan*	0	2	2	4 (+ 3)
University of Manitoba	0	5 (-1)	4 (-1)	9 (- 2)
University of Guelph	4	10 (+1)	5 (0)	19 (+ 5)
University of Toronto	0	1 (-2)	3 (-1)	4 (- 3)
McGill University	0	5 (-2)	4 (-3)	9 (- 6)
Laval University*	0	6	6	12 (+ 9)
Other	1	20	3	24 (+12)
U.S. and Foreign Universities	0	1	7	8 (+ 6)

* Individual breakdown by degree and university are not available from 1975 survey.

**Net change in total number of graduate students at each university between 1975 and 1983 in parentheses.

As in 1975, approximately 60% of the graduate students were enrolled in M.Sc. programs (50 male, 27 female) and 40% in Ph.D. programs (37 male, 11 female). The proportion of women pursuing graduate studies in entomology increased from 18% in 1975 to 31% in 1983 with more seeking master's degrees and fewer seeking doctorate degrees. As in 1975, the two most popular specializations selected by graduate students, both as the primary and secondary choice, were ecology and applied pest control — biological (Table 11). The proportion of students studying ecology increased, while that studying applied pest control — biological, decreased. Systematics and forest entomology were also popular specialities in 1983.

Research was by far the most preferred function of graduate students with a substantial increase in this function since 1975 and a corresponding decrease in the teaching function (Table 12). Students showed increased flexibility with 73% indicating that they would accept employment anywhere in Canada or throughout the world.

Table 11. Number of graduate students according to specialization in 1983.

Specialization	Primary Student Choice by Program			Total	
	B.Sc.	M.Sc.	Ph.D.	1st Choice	2nd Choice
Apiculture	1	3	2	6 (+ 2)*	3
Applied Pest Control — Biological	1	13	8	22 (- 9)	27
Applied Pest Control — Chemical	1	4	0	5 (- 4)	9
Ecology	2	26	21	49 (+23)	24
General	0	0	0	0 (- 9)	0
Morphology	0	1	0	1 (- 2)	1
Physiology	0	3	1	4 (- 4)	8
Systematics	1	9	6	16 (+ 5)	11
Toxicology	0	1	0	1 (- 3)	2
Forest Entomology**	0	11	4	15 (+15)	4
Plant Protection**	0	2	0	2 (+ 2)	0
Other**	0	4	5	9 (-10)	5
TOTAL	6	77	47	130	

* Net change in number of students between 1975 and 1983 in parentheses.

**Forest Entomology and Plant Protection were not included in the 1975 survey and their inclusion here may account for the reduction in the number listed as "Other."

Table 12. Function preferred by entomology students in 1983.

Number of Students											
Admin.	Extn.	Consult.	Surv.	PCO	Regul.	Res.	Teach.	Tech.	Dev.	Sales	Other
0	12	8	4	8	0	89	6	0	0	0	
(-1)*	(+1)	(+1)	(0)	(+1)	(0)	(+25)	(-18)	(-1)	(0)	(0)	

*Net change in number of students selecting each function between 1975 and 1983 in parentheses.

THE DEMAND FOR AND SUPPLY OF ENTOMOLOGISTS

In the 1983 survey, 62 (42%) of 146 questionnaires sent to managers of entomologists were returned. As several large groups of entomologists were not represented in these returns, it was felt that detailed analyses of the returns would not produce valid data. Projections, based on retirement plans, however, proved reasonably accurate in 1975 and these data were available from the professional entomologists questionnaire. Therefore, in 1983, retirement data were used to estimate the number of entomologists required over the next 5 and 10 years (Table 13). Although these estimates assume that all positions will be filled by entomologists in a similar sub-discipline, they are probably conservative in that 100% response to the survey was not attained. In most specializations the proportion of entomologists retiring in the first 5 years was greater than that planning retirement within 5 to 10 years. The training of, and degrees expected by entomology students was shown in Table 11. All but 3 students will have completed their studies within the next 5 years while all doctoral candidates will have graduated within the next 4 years. In the next 5 years, there will be 121 graduating students. In almost all specializations there will be an oversupply of entomology students. The exceptions are in pest control — chemical, morphology, and toxicology.

Table 13. Number of entomologists in the present work force and employment opportunities based on retirements by specialization.

<i>Specialization</i>	<i>Total Number in Present Work Force</i>	<i>Number Retiring</i>	
		<i>5 Years</i>	<i>10 Years</i>
Apiculture	15	2	2
Applied Pest Control — Biological	62	11	16
Applied Pest Control — Chemical	59	11	17
Ecology	110	17	14
General	6	0	0
Morphology	14	2	2
Physiology	25	3	4
Systematics	46	8	13
Toxicology	12	1	4
Forest Entomology	67	5	9
Plant Protection	15	2	5
Other	37	7	11
TOTAL	468	69	107

1. *Apiculture*
There is a significant oversupply of apiculturists in view of the very low demand. Only 2 apiculturists will be required in the next 10 years while 6 will have graduated by 1988.
2. *Applied Pest Control — Biological*
Eleven positions will be open in this specialty in the next 5 years and 16 in the next 10 years. Twenty-two students are presently in training in this specialty with 20 graduating by 1988. There is an oversupply at both the doctorate and master's levels for the next 5 years. This oversupply is compounded by the large number of entomologists receiving secondary training in applied pest control — biological.
3. *Applied Pest Control — Chemical*
Eleven positions will be open in this specialty in the next 5 years and 17 in the next 10 years. There is an under-supply at each educational level in this specialization.
3. *Ecology*
There will be 17 openings for ecologists in the next 5 years and 24 in the next 10 years. Despite this very high demand, there is still an oversupply of students especially at the master's level.

5. *Generalists*
No generalists are retiring in the next 10 years and none are being produced. There are very few entomologists in this category.
6. *Morphologists*
Two morphologists will retire in the next 5 to 10 years while only 1 morphologist is receiving training at this time at the master's level. There is a very low demand in this area, and a low supply.
7. *Physiologists*
Three physiologist positions will be open in the next 5 years and 4 in the next 10 years. Four students are receiving training in physiology, 3 master's and 1 doctorate. This would indicate a slight undersupply at the doctorate level and oversupply at the master's level. An additional 8 students, however, are receiving secondary training in this field and as a result there may be a slight oversupply.
8. *Systematics*
Eight positions will open in systematics in the next 5 years and 13 in the next 10 years. Supply equals demand in the next 5 years at the doctorate level, but a substantial oversupply exists at the master's level.
9. *Toxicologists*
One position will open in this field in the next 5 years, and 4 in the next 10 years. This field is undersupplied as only 1 student is receiving primary training at the master's level.
10. *Forest-Entomology*
Five positions will open in forest entomology in the next 5 years and 9 in the next 10 years. This area is oversupplied at both education levels with 11 students graduating with master's degrees and 4 with doctorates in the next 5 years.
11. *Plant Protection*
This category must be considered in conjunction with applied pest control — biological, and chemical. Considered by itself, there is an undersupply. Two openings will occur within the next 5 years and 5 within the next 10 years. Only 2 entomologists are being trained in this area at the master's level. Those trained in applied pest control — biological, however, in which there is an oversupply, may qualify for plant protection openings.

The supply of, and demand for, entomologists as analysed by function indicates that most students prefer research as a primary function followed by extension, consulting, and applied pest control (Table 14). Teaching was a surprisingly low proportion of the first choice although it was the largest second choice. When first and second preferences are considered, there is little imbalance with the current situation.

Table 14. Percentage of students indicating their choices for work function and percentage of current work force in entomology employed in each function.

Function	Student Choice (%)			Entomologists Employed in Function (%)
	1st	2nd	3rd	
Administration	0	1	4	7
Extension	9	9	11	6
Consulting	6	11	17	2
Survey	3	10	17	3
Pest Control Operations	6	11	16	3
Regulatory	0	1	1	3
Research	69	17	8	60
Teaching	5	38	19	10
Technical Development	0	2	7	3
Sales	0	0	0	0
Other	2	0	0	4
Unknown	5	6	25	3

DISCUSSION

This report provides a brief overview of entomological personnel in Canada and has identified several areas requiring the attention of administrators, policy-makers, and entomologists. As noted in the 1975 report, there was and there remains, a significant imbalance in the predicted demand for, and supply of, entomologists in the next 5 years. In some specializations the supply will be 2 to 3 times the predicted demand, while in a few specializations supply will not meet demand. Some 121 students of entomology will be graduating in the next 5 years while only 69 openings are expected during that time. The fate of many of these students is probably to leave the country or leave the profession. This process is already occurring as evidenced by the number of questionnaires returned by students now in other professions. In 1975, it was recommended that efforts be made to improve communication between employers and producers of entomologists so as to reduce this substantial imbalance. Data in our report indicate that this situation still exists to the same extent as in 1975 and that these recommendations were not implemented, except in physiology.

In terms of specialization, the present report suggests that there has been little change in the career preferences of students receiving advanced training. Ecology and applied pest control — biological, are still selected by students over applied pest control — chemical, and toxicology despite definite career opportunities in the latter and limited opportunities in the former. Changes have occurred, however, in the functions to which students aspire. Significantly more foresee their professional role as researchers rather than as teachers. This may reflect dissatisfaction with the educational system as a whole or, more likely, a general shift in emphasis within the educational institutions from teaching to research. Support for this theory comes from the educational institutions themselves where more professors see their primary function as research.

The number, geographical location, and educational level of entomologists in Canada has remained almost unchanged since 1975. Generally, the primary functions of entomologists also remained the same with research first (60%) and teaching second (10%). In addition, the proportion of entomologists within each primary specialization was the same as in 1975, with ecology, forest entomology, applied pest control — biological and chemical, being the most common. Very few entomologists classified themselves as generalists. As with other disciplines, there appears to be a shift in entomology towards specialization.

Of particular interest in the 1983 survey was the increase in the number of women involved in entomological work. The proportion of female entomologists in the labour force increased 4% between 1975 and 1983. This trend will definitely continue as almost one-third of all entomology graduate students are women. Female entomologists were younger than their male counterparts, were more involved in applied pest control — biological, and physiology, and were more likely to have completed a master's degree than a doctorate degree. They were more apt to work in extension services within the provincial governments than research positions within the federal government. Female entomologists had fewer support staff and lower salaries than male entomologists in similar positions although this may have been due to their overall lower degree of education and age.

Both in 1975 and 1983, industry employed fewer entomologists than the other sectors. It appears that the recommendation put forth by the Lamontagne report with respect to the transfer of research capabilities by the federal government to the industrial sector has not been implemented on a large scale.

At educational institutions, there has been a marked shift in emphasis from teaching to research. Most entomologists at educational institutions plan to remain until age 65 (76%). The general increase in staff support for entomologists was particularly apparent at educational institutions. This probably reflects an increase in the amount of contract funding available to these institutions.

In summary, there were no major changes in human resources in entomology in Canada between 1975 and 1983. The number of entomologists in the labour force remained fairly constant and the trend to a reduction in numbers seen up to 1975 was not continued. At educational institutions, a decided shift in priorities, from teaching to research, has occurred. Recommendations in 1975 emphasized the "immediate and continuing need for effective long-term science policy by employers and the transfer of this policy to the universities". Despite this, the major imbalance between the projected supply of graduate students and the demand for their services observed in 1975 is still apparent today. Entomologists have an important role to play in Canada's future and a considerable number of young Canadians wish to be educated in this field. Therefore it is important that those policies which will set priorities for future employment for entomologists should also be compatible with the direction of future entomological training.

FOOTNOTES

¹A Manpower Study of Entomologists in Canada. Entomological Society of Canada. 1983.

²Statistical Package for the Social Sciences. 1975 Nie, N. H., C. H. Hull, J. G. Jenkins, K. Steinbrenner, and D. H. Brent. 2nd Edition. McGraw-Hill, Inc., Toronto. 675 pp.