67 [J.J. Tompkins], *Knowledge for the People: A Call to St Francis Xavier Co* (Antigonish: privately published, 1921), 9–10. The authorship of this pamp which was distributed by the People's School, is established by a letter of T kins to R.F. Phalen, 22 Nov. 1920, St Francis Xavier University Archives, Tompkins Papers, RG30-2/110/71.

68 Daniel W. MacInnes, "Clerics, Fishermen, and Workers: The Antigonish Mo ment and Identity in Eastern Nova Scotia, 1928–39" (PhD thesis McMaster U versity 1978), 112.

69 Tompkins to Learned, 5 Oct. 1922, Maritime Provinces Educational Federation Files, CCA.

70 Tompkins to Angus L., Macdonald, 23 Nov. 1922. MG2, Angus L. Macdonald Papers, cabinet 5, folder 1348, Public Archives of Nova Scotia, Halifax, NS.

71 Tompkins to Henry Somerville, 25 Feb. 1921, Tompkins Papers, MG10-2, 5(a) Beaton Institute; Brown, "The People's School," 363. On Ruskin College and troubled relationship with the Marxist stream of the labour movement, see Brian Simon, *Education and the Labour Movement, 1870–1920* (London: Lawrence and Wishart 1965), 311–26.

72 *Halifax Chronicle*, 2 Jan. 1933.

73 *Wesleyan*, 26 Aug. 1896.

74 Sir Andrew MacPhail, *The Master's Wife* (Toronto: McClelland and Stewart, New Canadian Library, 1977), 19, 112–24; see also Ian Robertson's introduction, xi.

75 Interview with David M. MacAulay, 7 Feb. 1977, Mount Allison University Archives.

76 Gene Hicks, 12 Aug. 1983, quoted in Paul Axelrod, "Moulding the Middle Class: Student Life at Dalhousie University in the 1930s," *Acadiensis* 15 (Autumn 1985): 89. See also Judith Fingard, "College, Career, and Community: Dalhousie Coeds, 1881–1921," in this volume, 34–5.

77 *Acadia Athenaeum* (Wolfville, NS), May 1922, 72; Mar. 1923, 44.

78 Learned and Sills, *Education in the Maritime Provinces*, 32; James Donaldson, in *Contemporary Review* 41 (1882): 150, quoted in Anderson, *Education and Opportunity*, 269.

79 *Dalhousie Gazette* (Halifax, NS), 15 Nov. 1922.

80 Brown, "The People's School," 363.

81 Anderson, *Education and Opportunity*, 308–9; Simon, *Education and the Labour Movement*, 248–9, 337–9.

82 *The People's School, Antigonish, N.S.* ([Antigonish]: The People's School [1921]), 22.

CHAPTER THIRTEEN

*Financial Support for Post-graduate Students and the Development of Scientific Research in Canada**

Yves Gingras

According to the historian Hugh Hawkins, "the fellowship as an award to attract graduate students ... was probably the crucial institutional invention that brought success to the early Johns Hopkins."[1] The importance of financial-aid programs for students in the development of graduate studies, and thus in the development of university scientific research, is beyond doubt. However, the organic connection between the generation of knowledge and the training of professors willing to specialize in research, rather than in teaching, is of relatively recent origin in Canada. Before the First World War young Canadians who wished to pursue graduate study in science so as to qualify themselves as researchers were forced either to become exiles at their own expense or to try to secure awards offered by foreign universities seeking to attract outstanding students. Moreover, once they had obtained their doctorates, these researchers had no assurance of being able to return and pursue their scientific inquiries, for in the early part of the twentieth century research was not a central concern of Canadian universities.

In order to understand the circumstances that made possible the development of scientific research in the universities of Canada, this essay will trace the origins of what can be regarded as the first thoroughgoing attempt to promote scientific research in Canada: the system instituted in 1916 and 1917 by the newly created National Research Council (NRC).[2] Although there was already a certain amount of research in progress at major Canadian universities earlier in the twentieth century, the secure integration of this activity into the institutions would depend upon the establishment of a financial-aid program for post-graduate study that would be able to attract and retain a sufficient clientele of potential research professionals. Doctoral programs had appeared in 1897 at the University of Toronto and in 1906 at McGill, but the output of graduates at either master's or doctoral levels did

not increase significantly until after the First World War. When it came, the increase owed much to the financial aid of the NRC.

Before examining in detail the ways in which the intervention of the NRC stimulated the growth of university scientific research, it is necessary to examine the major sources of financial support available to Canadian students before 1916. These programs enabled some young Canadians to obtain research training outside Canada, and this equipped them to bring to Canadian universities a new concept of the role of the professor. The professor, they would argue, should not be limited to teaching but should be budgeting time and resources for research.[3] Also, since the existence of research-based post-graduate degree programs was a further stimulus to systematic research, it is necessary also to consider the circumstances that prompted the University of Toronto and McGill University to introduce such programs.

THE GILCHRIST SCHOLARSHIP: AN INDIRECT APPROACH TO GRADUATE STUDY

The Gilchrist Scholarship, inaugurated in 1868 and applicable to any discipline, was awarded annually to a Canadian who wished to study for a BA degree at either the University of London or the University of Edinburgh.[4] In practice, however, most holders of the scholarship had already received their first degrees in Canada and saw little benefit in further undergraduate study. Most would use the scholarship to study at the post-graduate level. This practice implied that candidates would study simultaneously for their graduate research and for their BA finals, and this eventually led to criticism of the program. In 1886 a Dalhousie University statement called for elimination of "the provision that the student has to become a candidate for a degree because of loss of time."[5] Nine years later a report prepared by former holders of the scholarship suggested that the strain of preparation had undermined the health of some candidates.[6] In 1897 the program was abandoned. Nevertheless, it had provided support for eighteen students, of whom seven would go on to be professors in Canadian universities. Among the seven who specialized in science, three would pursue their careers in Canada: S.W. Hunton taught mathematics at Mount Allison, W.L. Goodwin chemistry at Queen's, and J.G. MacGregor physics at Dalhousie.[7]

Because it was awarded to only one student per year, the Gilchrist scholarship could not have any major overall effect on the development of post-graduate studies in Canada, except perhaps indirectly, as illustrated by the career of MacGregor, who was able to pass on to his post-graduate students the benefit of the training in research that he had received in Edinburgh. Oddly enough, the opening of Johns Hopkins University in 1876 would have more effect on the development of graduate study in Canada than did the scholarship offered by the "mother country."

THE BEGINNINGS OF DOCTORAL PROGRAMS AT THE UNIVERSITY OF TORONTO AND MCGILL

In order to widen the clientele of their new, research-based doctoral programs, universities in the United States offered scholarships to their most able students regardless of nationality. Johns Hopkins began this trend, followed by Cornell, Harvard, and Chicago. Canadian students, just as aware as their American counterparts of the advantages to be derived from studying in these programs, did not hesitate to cross the border in large numbers. During the last quarter of the nineteenth century the four universities mentioned had an enrolment of almost three hundred Canadians, and more than one-third of these received financial support.[8] Of the total number close to one-third came from Toronto, and these students accounted for half of the bursaries received. The University of Toronto, especially hard hit by this exodus of students to the United States, was not surprisingly the first to react.[9]

In 1883 the administrators of the University of Toronto offered nine post-graduate scholarships of five hundred dollars, equal in value to those available at Johns Hopkins.[10] However, whereas at Johns Hopkins the recipients devoted all their time to the preparation of a doctoral thesis, at Toronto they had to assist their professors in teaching duties. Because the university was in a precarious financial situation, departments rapidly came to use these funds simply to hire instructors and demonstrators. At universities in the United States the award of scholarships was tied to a well-defined course of study leading to the doctoral degree. At Toronto, by contrast, the awards represented a hasty effort to ward off the dangers of competition from the south, and there was no genuine structure of post-graduate instruction. Because the work of the scholarship-holders did not lead towards a doctoral diploma, the net result was to intensify the trend towards study in the United States. There, the same work would result in the acquisition of the PhD degree, which was increasingly a necessity for anyone aspiring to a university career.

The first step towards a real solution of the problem of student emigration was not taken until 1897, when the University of Toronto introduced its doctoral program.[11] In July of that year, in the first issue of the *University of Toronto Monthly*, university president James Loudon stated clearly the argument that he had been pressing within the university community for twenty years: "The old ideal of a University as merely an institution for the transmission of knowledge is passing away. This ideal is that of the College as contrasted with the University proper which has the additional function of adding to the sum total of knowledge by original research."[12] In the same year the university calendar announced that "the degree of Doctor of Philosophy has been established for the purpose of encouraging research in the

University." Correspondingly, the *University of Toronto Series* was launched as a means of publishing theses and other works arising from the research of the professors.

This first doctoral program, which initially had no formal structure of courses, evolved under American influence to take its final form during the 1910s. In 1904 the master's program was modified to include the presentation of a paper embodying the results of original research.[13] According to A.B. Macallum, first director of the university's board of graduate studies, these changes were long overdue; if implemented fifteen years earlier, he believed, they would have given direction to the work of the earlier scholarship-holders, to the great benefit of the development of graduate studies at the university. Macallum was well placed to make this judgment, since he had proceeded after graduation from the University of Toronto to obtain a PhD at Johns Hopkins in 1888.[14]

At McGill the first modifications to the master's program were made in 1899, and the PhD degree was not adopted until 1906.[15] Even this institution, which had always enjoyed a privileged relationship with the major British universities and had recruited most of its professoriate in Great Britain, had no alternative but to adapt to North American trends. The McGill doctoral program, like that of the University of Toronto, was heavily influenced by the United States model, and led in 1922 to the creation of a Faculty of Graduate Studies.[16] In the same year the University of Toronto adopted a similar structure under the title of School of Graduate Studies.[17] When, in 1926, the two institutions became members of the Association of American Universities – founded in 1900 in order to co-ordinate the post-graduate offerings of American universities – this was a logical culmination of their increasing assimilation into a North American pattern.[18]

Yet in practical terms post-graduate studies in the sciences, whether at Toronto or McGill, received their real stimulus in the launching in 1917 of the National Research Council's program of fellowships for master's and doctoral students. Before that date McGill had awarded only one doctorate a year on average, all disciplines included.[19] The average at the University of Toronto was the same during the period from 1896 to 1907, and rose to two per year during the ensuing decade.[20] Until the end of the Second World War these two were the only institutions offering the doctoral degree in most disciplines.[21]

THE ADVANTAGES OF COLONIALISM: THE ROLE OF THE 1851 EXHIBITION SCHOLARSHIP IN THE TRAINING OF CANADIAN SCIENTISTS

Before the establishment of the National Research Council students interested in a scientific career could expect no significant financial aid from Canadian universities. Fortunately for them, developments in England did

enable them to benefit from a program of scholarships designed specifically for young scientific graduates aspiring to training in research. In the mid-nineteenth century a movement in favour of the development of industrial research emerged in England. First taking shape in the report of the 1850 commission of inquiry on the Universities of Oxford and Cambridge, the movement gathered force with the appointment of the Devonshire Commission on technical education, and resulted in 1890 in the creation of a system of scholarships intended to encourage the training of scientists who would contribute to the industrial development of the British Empire.[22]

In 1890 the Royal Commission for the Exhibition of 1851 announced the creation of a new program of scholarships. Charged with the management of the accumulated profits of the Great Exhibition, the commission had already given assistance to such national institutions as the South Kensington Museum and the Royal College of Arts and Science. Now a study committee was quickly established. Following wide consultation its chairman, John Playfair, recommended the launching of a scholarship program similar to that already developed by Jean-Baptiste Dumas at the École pratique des hautes études in Paris. The scholarships proposed by Playfair would amount to £150 a year and would be open to British subjects under thirty years old who had demonstrated during their university studies a special aptitude for, and interest in, research in pure or applied science. Applicants were free to pursue their studies for two or three years in Great Britain or elsewhere in the world.[23] Of the twenty scholarships to be offered each year from 1891, six were to be awarded to parts of the empire outside of Britain, and two of these were reserved for Canada.

The scholarships were further designed exclusively for the scientific disciplines: biology, chemistry, geology, physics, and engineering. From 1891 to 1917 they played an important role in the training of Canadian scientists. R.T. Glazebrook, the director of the program, summed up in 1930 the significance of the 1851 Exhibition Scholarships, in the preface to a report that analysed the career patterns of those who had received the awards:

> Established at a time when the field was still untouched by any system that carried training beyond the limits of ordinary degree curricula, these scholarships have undoubtedly given a great and much needed impetus to postgraduate study. They certainly played an important part in raising the standard of teaching in the younger Universities and Colleges of the Empire, and the hope, originally entertained, that in the yearly allocation within the Empire of some eighteen scholarships, a body of well-trained men of science who would be able to extend the bounds of natural knowledge, has since been abundantly realized.[24]

This judgment is borne out by the case of Canada and by the evidence from the four universities that participated in the program: McGill and the University of Toronto shared one scholarship, each university awarding it

in alternate years, as did Queen's and Dalhousie. Although McGill and Toronto were already relatively well equipped in the sciences, Queen's and Dalhousie (integrated into the program in 1893 and 1894 respectively) were much less so. Especially at Dalhousie, science teaching benefited greatly from participation in the scholarship program. A committee appointed by the Dalhousie board of governors to study the implications of the new initiative reported that scientists at the university "have never been authorized by the Board of Governors to make a greater annual expenditure on ... [physics and chemistry laboratories] than is necessary for conducting the ordinary university classes ... and that while at present some facilities for research in a few very narrow departments can be afforded ... it will in two or three years be impossible not only to provide these meager facilities but even to provide practical instruction of any kind."[25] The committee estimated that an annual investment of $100 in each laboratory would be enough to halt the deterioration, but that any major improvement would be produced only with new annual expenditures of $300 to $400. It went on to conclude that the offer of an 1851 Exhibition Scholarship could be accepted by Dalhousie for the years 1894 and 1896 if $100 per year was spent on each laboratory, but that "the periodical repetition of the Commissioners' offer cannot be expected unless an additional annual expenditure of about $100 or $150 on each laboratory can be provided for."[26]

As a result the governors authorized the university senate, from 1894, to disburse up to $400 annually for laboratory improvements. The new expenditures allowed the physicist J.G. MacGregor, for example, to buy new apparatus that he had been denied for some years, and thus to "afford greater facilities for original research."[27] MacGregor was put in a position not only to carry out more research himself but also to give effective training to students. He gave his own evaluation in 1901, in a letter of application for the position of professor of natural philosophy at the University of Edinburgh: "Following the traditions of the Edinburgh Laboratory, I have endeavoured to stimulate my students to engage in research. My Advanced Practical Class was organized for this purpose eight years ago, and during this time a number of investigations have been made which have given results worthy of publication."[28] MacGregor was successful in his application, and later in 1901 he succeeded his mentor, Peter Guthrie Tait, to the chair at Edinburgh. During his time at Dalhousie he had trained at least eight students in research; their work had given rise to seventeen publications, all dealing with the physical-chemical properties of aqueous solutions. All of these students had enjoyed 1851 Exhibition Scholarships, and the majority of them used the scholarship to obtain doctoral degrees in physics or chemistry from universities in the United States before finding scientific employment either there or in Canada.[29]

By contrast with Dalhousie, McGill and the University of Toronto were able to meet the requirements of the scholarship program without difficulties.

Table 1

Destinations of 1851 Exhibition Scholars, by institution of origin, 1891–1914, all disciplines included

University of origin	*United States*	*Great Britain*	*Germany*	*Other countries*	*Total*
McGill	4	7	3	0	14
Toronto	1	4	7	0	12
Queen's	6	2	4	0	12
Dalhousie	10	1	1	0	12
Total	21	14	15	0	50[1]
% of Canadian recipients	42	28	30	0	100
% of colonial recipients[2]	20	52	20	8	100

Sources: *Record of the Science Research Scholarship of the Exhibition of 1851* (London 1930); R.M. MacLeod and E.K. Andrews, "Scientific Careers of 1851 Exhibition Scholars," *Nature* 218 (15 June 1968): 1013–14.

1 The total is larger than the total number of recipients (47) because some visited two countries on the same scholarship.

2 The colonies included were Australia, Canada, New Zealand, and South Africa.

McGill nominated its first 1851 Exhibition Scholar in 1891, and Toronto did the same the following year. From 1893 onwards McGill and Queen's named scholars in the odd-numbered years while Toronto and Dalhousie did so the even-numbered years. From 1891 to 1914, because of this financial aid from Great Britain, forty-seven Canadian students were able to acquire scientific training in the leading research laboratories of the world.

Analysis of these recipients (see Table 1) shows that by no means were all of them attracted to study in Britain. Scholars from Toronto and McGill frequently did go there, but those from Queen's and Dalhousie tended to go to the United States. Overall, the Canadians were drawn much more to the United States and Germany than were recipients from other parts of the empire, who overwhelmingly opted for Britain. There was also variation according to discipline. A large majority of students in chemistry went to Germany and used the scholarship to study at the famous laboratory of Wilhelm Oswald in Leipzig. Physicists from McGill and Toronto normally went to Britain, but Dalhousie physicists most often studied at the major American universities. These two different directions reflected to some extent the histories of the various departments and the varying networks or relationships that they had built over the years. The evidence also indicates that, contrary to conventional interpretations, the colonial relationship between Britain and Canada did not prompt Canadian science students to

Table 2
Area of specialization of 1851 Exhibition Scholars, by institution of origin, 1891–1914

University of Origin	*Physics*	*Chemistry*	*Biology*	*Geology*	*Engineering*
McGill	6	4	1	0	2
Toronto	6	5	1	0	0
Queen's	2	2	1	6	0
Dalhousie	4	7	0	0	0
Total	18	18	3	6	2
% of Canadian recipients	38	38	6	13	4
% of colonial recipients	49	24	10	9	8
% of British recipients	31	54	7	3	5

Sources: as Table 1.

gravitate inevitably towards Cambridge.[30] A significant factor was the shortage of doctoral programs: those students who studied in the laboratories of British universities would attain only a BA or MA degree, while those who chose universities in the United States or Germany would return with a doctorate. This discrepancy was often noted with disapproval by Canadian university presidents.[31]

As regards the choice of disciplines, Canadians conformed to the general pattern. Physics and chemistry (see Table 2) were far ahead of the rest. The British, perhaps responding to industrial needs, awarded almost twice as many scholarships to chemists as to physicists. Among the imperial recipients that proportion was reversed. Within Canada the universities of Toronto and McGill – with the large endowments – had well-established departments in several of the disciplines, and this was reflected in the choices of their candidates. At Queen's the majority opted for geology; since the opening of the School of Mining in 1893 this had been the university's chief area of scientific specialization.

Even if only half the scholarship recipients subsequently carried on their scientific careers in Canada and if the others found employment in Britain or the United States, it is not justifiable to conclude, with Robin Harris, that the 1851 Exhibition Scholarship program either did not advance or may have retarded the development of graduate studies in Canada.[32] In physics, for example, eleven of the eighteen award-holders returned to Canada, and

ten continued to be active in research, nine in the universities and one at the meteorological office of the federal government. Seven of them became members of the Royal Society of Canada and can be regarded as having played an active role in the development of the discipline of physics in the country. To be sure, the limited number of scholarships available – two each year – and the fact that they were used for study at universities outside Canada combined to ensure that the program could never supply a comprehensive, long-term solution to the problem of how to stimulate scientific research at Canadian universities. Nevertheless, it is fair to conclude that, between 1891 and 1917, the 1851 Exhibition Scholarships did play a significant part in the formation of the first nucleus of Canadian scientific researchers and that these early scientists were then instrumental in generating research activity at Canadian universities.

THE FIRST WORLD WAR: A FAVOURABLE CONJUNCTURE FOR THE GROWTH OF RESEARCH

"In 1906," remarked H.J. Cody to the Royal Society of Canada forty years later, "research did not occupy its present position in the thought and practice of our Canadian Universities."[33] For a variety of reasons, however, that early twentieth-century situation was about to change. Part of the explanation, as already discussed, lay in the increasing presence in Canadian universities of professors who had been trained in research and who intended to continue as active scientists. Even more important was the influence of the First World War. The conjuncture of wartime circumstances brought about the discussion of scientific research as a matter of national importance that should no longer be the sole responsibility of a handful of scientists at a few universities. During the decade of the 1910s the movement for industrial research gathered strength in Canada. The movement was prompted by the industrial establishment, working through the Canadian Manufacturers' Association and with the Royal Canadian Institute acting as a bridge between industry and the universities. The war made it clear how completely Canadian industry had depended on equipment and technologies imported from Europe.[34]

The pressures exerted by industrial leaders, with the support of the presidents of the major universities, led eventually to the creation, in November 1916, of the Honorary Advisory Council for Scientific and Industrial Research, which soon came to be known as the National Research Council of Canada (NRC).[35] Made up of eleven government-appointed members, the NRC was dominated from the start by university scientists.[36] This university predominance stemmed from the fact that industrial research was virtually non-existent in Canada and that it had been the universities – working through

the Canadian Institute of Toronto, and with the support of the Canadian Manufacturers' Association – that had ultimately taken the most active role in pressing the government for action. Throughout the first three decades of the twentieth century, in fact, the promotion of scientific research in Canada was effectively the preserve of a small number of individuals who met frequently – not only at meetings of the NRC, where their regular attendance ensured in itself that they would have a powerful voice, but also at meetings of the Royal Society of Canada and of the National Conference of Canadian Universities (NCCU).

A NATIONAL PROGRAM OF POST-GRADUATE FELLOWSHIPS IN THE SCIENCES

Although the administrators of the major universities had already recognized increasingly the importance of scientific research and of training scientists, the institutions' financial difficulties had hindered the translation of this support into tangible form. At Toronto, for example, the introduction of the PhD program did not lead until 1916 to the establishment of an adequate structure of financial assistance for post-graduate students. The introduction of postgraduate fellowships at that time was, according to J.C. McLennan, the head of the Physics Department, a crucial development. McLennan had been arguing for such a scheme for many years in the interests of securing a healthy future for research in his department, and in 1916 he wrote to the university president, R.A. Falconer, that "it looks as if a new era is opening for the University and I look forward for happier days now."[37] There was reason for McLennan's optimism, all the more so because the NRC would also be instituting a scheme of post-graduate financial support just a few months later. Ultimately, the University of Toronto fellowships would be directed to the disciplines not covered by the NRC awards.

A leading role in the development of the NRC fellowship scheme was taken by A.B. Macallum, former director of the University of Toronto's board of graduate studies and now the first chairman of NRC. Several months before his appointment Macallum had argued at a meeting of the NCCU that "the two great needs of Canadian Graduate Schools were scholarships and increased library facilities, because it was through these that the American Universities were able to attract so many of our Canadian Graduates."[38]

Accordingly, action was taken at the first meeting of the NRC, in December 1916. The university-based members formed themselves into a committee to study the operating principles of the 1851 Exhibition Scholarship and to make recommendations on Canada's particular needs.[39] Two types of assistance were eventually established. "Studentships," valued at $600 for the first year and $750 for the second, were to be awarded to applicants entering on their scientific studies, normally at master's level. "Fellowships," valued at $1,000 the first year and $1,200 the second, were directed to doctoral students.[40] As was true of the 1851 Exhibition Scholarships, the awards were to be confined to students who had already shown "high promise of capacity of advancing science or its applications by original research."[41] Both pure and applied sciences were covered by the programs. The first awards were made in September 1917, less than a year after the creation of the NRC.[42] Although seventy awards had been anticipated, wartime conditions limited the number to seven. Not until 1923, in fact, did the NRC reach the point of spending its entire annual budget of $120,000.

The NRC studentships and fellowships undoubtedly met the requirements of universities such as McGill and Toronto, which were already capable of introducing undergraduate students to research methods, thereby enabling them to qualify for studentships. At a profound disadvantage, however, were those institutions that were less well equipped. There, students had little opportunity to participate in research as undergraduates and so could not demonstrate their "high promise of capacity for advancing science." The result was a circular situation, where a student had to have had experience in research before being considered qualified for training. To break the cycle the NRC instituted in 1919 a system of bursaries. Worth $500, a bursary was intended to give encouragement to able students to begin postgraduate study. Any students who showed, in the first year, "distinct evidence of capacity for original research" would then qualify for a studentship.[43]

Analysis of the distribution of these different types of award shows that, had the bursaries not been offered, universities such as Dalhousie, Queen's, and those in the west would have been unable to benefit from any of the NRC awards. Even as it was, studentships and fellowships were virtually the preserve of McGill and the University of Toronto. Of the 78 studentships and fellowships awarded in physics from 1917 to 1939, for example, 3 went to Queen's students and 1 to the University of Manitoba. The University of Toronto, meanwhile, received 56 and McGill 28. Of the 100 bursaries awarded in physics from 1920 to 1939, 37 went to the smaller universities; even so, Toronto received 31 and McGill 32.[44] Despite variations among disciplines, reflecting the unequal strength of activities among the various scientific departments, the overall predominance of these two universities (see Table 3) was overwhelming. This was inevitable not only because of their large endowments but also in view of the expressed opinion of A.B. Macallum, as NRC chairman, that these two universities should be made centres of post-graduate study for the graduates of all Canadian institutions. As early as June 1918 Macallum put this argument in a letter to his sometime Toronto colleague J.C. McLennan:

One of our great difficulties, in connection with studentships and fellowships, is going to be the places of tenure of these positions. Already three of our fellows

Table 3
Number of National Research Council post-graduate awards, by year and university, 1917–39

University	Year beginning 19–																						Total
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
Toronto	3	2	9	13	21	18	16	12	17	14	16	14	11	19	15	7	6	4	4	3	9	nd*	233
McGill	3	5	5	6	11	14	16	18	14	18	22	22	28	32	26	nd	8	16	20	17	24	nd	325
Queen's	—	—	2	1	2	1	5	3	3	2	3	4	1	4	4	5	1	3	2	3	3	nd	52
Alberta	1	—	—	1	—	—	2	1	1	1	1	1	1	—	—	nd	—	—	—	—	—	nd	10
Manitoba	—	—	—	2	1	1	3	3	1	1	1	—	—	—	—	nd	—	1	—	—	—	nd	14
Saskatchewan	2	—	1	—	3	—	1	1	2	2	1	6	4	2	2	nd	1	—	1	1	1	nd	33
British Columbia	—	—	1	—	2	3	4	1	—	—	—	—	—	1	—	nd	—	—	—	—	—	nd	12
Dalhousie	—	—	—	2	1	—	—	—	1	2	3	—	1	1	1	nd	—	—	1	1	1	nd	15
Montreal	—	—	—	—	—	—	—	3	2	1	—	—	1	1	—	nd	—	—	—	1	1	nd	10
Laval	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	nd	1	1	1	2	1	nd	7

Source: annual reports of National Research Council.
* nd = no data.

have expressed a request to go to the American Universities, which the Council did not think wise to grant. When immediately after the war the number of studentships and fellowships may be increased to fifty, and, ultimately, to one hundred, the problem will become an acute one, and, in view of this, I am proposing that the universities of Toronto and McGill should establish Science Research Faculties, composed of staffs specially selected for research work and the guidance of graduates desirous of entering a scientific career.[45]

In the previous year, during the fourth meeting of the NCCU – held in Ottawa immediately following a meeting of the Royal Society of Canada – Macallum had joined with F.D. Adams, C.J. Mackenzie, and the future president H.M. Tory to prompt the passage of a resolution setting up a special committee chaired by Adams, "to take up with the authorities of the larger Canadian universities the question of organizing jointly graduate work leading to the Ph.D. degree, and that it reports the result at the next meeting of this conference."[46] Later meetings of the NCCU took the proposal so far as to discuss the creation of a national post-graduate university. This scheme had no chance of succeeding, however, because of the fierce competitiveness of the existing universities in their efforts to attract students and in view of the constitutional principle by which education came within provincial jurisdiction.[47] In effect, while the discussions went on, Toronto and McGill were steadily consolidating their ability to attract the majority of aspiring Canadian post-graduate students who did not wish to move to the United States. Their firm grasp on the NRC financial awards was both cause and effect of this consolidation. Because the recipients were obliged to undertake their research work at an institution "where the conditions are thoroughly suitable, and the accommodation ample, for such researchers," the two largest universities enjoyed a clear advantage.[48] Their output of science graduates, at both master's and doctoral levels, increased greatly from the early 1920s onwards.[49]

Obviously, the decision of the NRC to concentrate its financial aid at universities that were already well equipped for research work was not welcomed by all. Queen's University, spurred by the physicist A.L. Clark, was quick to respond by creating an inter-department committee on scientific research. In its first report, appended to the university principal's report for 1916–17, the committee stated its guiding principle forcefully: "It is essential, if Queen's is to maintain her rank among Canadian universities and is to contribute her proper share to the advancement of knowledge and to the development of our national resources, that increased attention and support be given to the world of research."[50] "Very little help is to be expected [from the NRC]," the committee continued, "to establish research work." It recommended that the university establish its own research council, charged with distributing grants to researchers and paying for the hiring of

research assistants. The support of summer research was to be emphasized, in view of the problems encountered by professors trying to combine research with their teaching commitments during the regular academic year. The committee further suggested that Queen's offer its own $600 scholarships and $1,200 fellowships.[51] Yet its plans were to prove unrealistic. Full implementation would have required an annual expenditure of $25,000 to $30,000. In its first year the university could provide only $10,000, and there was no guarantee of renewal. As a result, no financial awards were made. Queen's did receive, between 1917 and 1927, nineteen awards from NRC. In terms of numbers of awards it was thus placed immediately behind McGill and Toronto and ahead of the eleven granted to the University of Saskatchewan. Queen's would retain this third-place status throughout the interwar years.

For A.L. Clark, the creation of the Queen's committee on scientific research was only the beginning. Appointed dean of Applied Science in 1919, Clark immediately suggested to G.Y. Chown, retiring as registrar and treasurer of the university, the endowment of a research professorship.[52] Chown agreed, and the Chown Research Professorship was created for the fields of chemistry or physics. The first incumbent was an English physicist, A.L. Hughes, who departed four years after his 1919 appointment to take up a position in the United States. He was succeeded by another physicist, the Australian J.A. Gray, who held the position until retirement in 1951. The establishment of this position had a marked effect on the expansion of research work in physics at Queen's. Between 1923 and 1939 the department's students gained fourteen NRC awards, three times as many as any other physics department except for those of McGill and Toronto. At the same time, the awards themselves were essential to the healthy development of research in the department.[53] Gray himself was quick to feel the absence of fellow-researchers, and in 1926 he confided to his mentor Ernest Rutherford that "I have only one research student at present. I have three X-ray outfits with a fourth one nearly complete and no one but myself to work them."[54] Happily for Gray, two of his students gained NRC awards in the following year, and by 1928 he was supervising three such award-holders.

For the members of the NRC the award of financial support to post-graduate students constituted only a first step towards the establishment of a systematic research capacity in Canada. With post-graduate awards to encourage students to enter on research, it was equally essential that professors should also be in a position to devote themselves to research activities. Therefore, as soon as the regulations for the post-graduate awards had been defined, the council set about designing a scheme for subventions to researchers.[55] The grants, made initially for a single year but renewable on reapplication, would "as a general rule, only be made to persons who are conducting investigation in established laboratories which possess the fundamental apparatus and facilities necessary for research of the nature proposed, and ... will not be made for the purchase of standard apparatus which a well equipped laboratory should possess."[56] Naturally, this gave a further advantage to institutions already well equipped – notably McGill and Toronto – and gave further cause for grievance on the part of the universities that thought they would be effectively excluded from the scheme.

CONCLUSION

Ten years after the inauguration of the programs providing financial awards to post-graduate students and grants to researchers, the NRC felt able to claim that "an active and efficient research organization has been built in Canada, through which the investigation of any problem of national importance can be undertaken." A total of 344 postgraduate awards had been made to 199 individuals, distributed among twelve universities. Although "the main purpose of scholarships ... [was] to train men in research work," the council cited 456 scientific publications by the recipients, which it regarded as a sign of the high quality of work accomplished. In the context of the old problem of emigration of scientists to the United States, the council reported with satisfaction that of 155 award-holders who had completed their studies, no fewer than 123 had remained in Canada.[57]

Most of these awards had gone to aspiring physicists and chemists. In physics Canadian universities had graduated, on average, only 1 PhD every three years between 1900 and 1919. From 1920 to 1930, with the help of the NRC awards, the rate increased to 2.5 per year, and to 6 per year in the ensuing decade. The rate of increase was just as rapid at the master's level: from 2 per year between 1900 and 1919 to 9 in the years from 1920 to 1930 and 12 between 1930 and 1940. Also in physics – though the pattern was similar in the other disciplines – the doctorates were granted by Toronto and McGill only. At the master's level, however, those universities accounted only for some 65 per cent of the total, a sign that other institutions, notably Dalhousie, Queen's, and the prairie universities, had also developed their research capacities.

The production of scientific publications had also been stimulated by the NRC programs, with chemistry and physics again the leading disciplines. The increase in research activity was reflected clearly in the meetings of the Royal Society of Canada. The number of papers presented to Section III (comprising physicists, chemists, astronomers, and mathematicians) had averaged nine per year from 1900 to 1915. Between 1923 and 1930 the average rose to almost one hundred, with physicists and chemists sharing equally in some 90 per cent of the total number of presentations.[58]

In summary, the programs of the National Research Council played a fundamental role in the development of scientific research at Canadian uni-

versities and prompted the growth of distinct research communities in the various disciplines. The existence of a systematized research capability was a necessary precondition for the creation of a national scientific community, which needs well-defined institutional structures in order to reproduce itself. Just as the Gilchrist awards and the 1851 Exhibition Scholarships facilitated the *emergence* of research as a new function of the universities, so the initiatives of the NRC provided for the *institutionalization* of this research capacity. Thus, the generation of professors who, at the turn of the century, had received their scientific training at universities in Europe and the United States was afforded the opportunity and the right to pursue research activities at Canadian institutions that had been devoted hitherto only to teaching.[59]

NOTES

* Translated from the French by John G. Reid.

1 Hugh Hawkins, "University Identity: The Teaching and Research Functions," in Alexandra Oleson and John Voss, *The Organization of Knowledge in North America, 1860–1920* (Baltimore: Johns Hopkins 1979), 25.

2 The council will be referred to as the National Research Council even though this title was not officially adopted until 1924. Before that time it was officially known as the Honorary Advisory Council for Scientific and Industrial Research, though commonly referred to simply as the Research Council. See M.L. Thistle, *The Inner Ring: The Early History of the National Research Council* (Toronto: University of Toronto Press 1966), 131.

3 On the emergence of scientific research in Canada, see Yves Gingras, "De l'enseignement à la recherche: l'émergence d'une nouvelle pratique de la physique dans les universités canadiennes," *Histoire sociale / Social History* 37 (May 1986): 73–91.

4 Robert A. Falconer, "The Gilchrist Scholarship: An Episode in the Higher Education of Canada," *Proceedings and Transactions of the Royal Society of Canada* (hereafter PTRSC), 3 rd ser., vol. 27 (1933): sec. II, 5–13.

5 Dalhousie University Archives, Minutes of the Faculty of Arts, 10 Dec. 1886.

6 Falconer, "The Gilchrist Scholarship," 10.

7 "William Lawton Goodwin (1856–1914)," PTRSC, 3 rd ser., vol. 39 (1945): 87–8; "James Gordon MacGregor, 1852–1913," *Proceedings of the Royal Society*, ser. A, vol. 89 (1913): xxvi–xxviii; on S.W. Hunton, see John G. Reid, *Mount Allison University*, vol. 1, *1843–1914* (Toronto: University of Toronto Press 1984), 185–6.

8 Figures from P.N. Ross, "The Development of the Ph.D. at the University of Toronto, 1871–1932" (Ed.D. thesis, University of Toronto 1972), 181. For the 1890s Robin Harris gives the following statistics: more than 30 at Johns Hopkins, more than 60 at Harvard, more than 50 at Cornell, and more than 80 at Chicago. R.S. Harris, *A History of Higher Education in Canada* (Toronto: University of Toronto Press 1976), 191–2.

9 Ross, "Development of the Ph.D.," 199; Harris, *History of Higher Education*, 188.

10 Ross, "Development of the Ph.D.," 89.

11 P.N. Ross, "The Establishment of the Ph.D. at Toronto: A Case of American Influence," in M.B. Katz and P.H. Mattingly, *Education and Social Change* (New York: New York University Press 1973), 193–214.

12 J. Loudon, "Changes and Progress," *University of Toronto Monthly* 1 (July 1897): 6–9; cited in Ross, "Development of the Ph.D.," 118.

13 Ross, "Development of the Ph.D.," 118–96.

14 A.B. Macallum, "The Foundation of the Board of Graduate Studies," *University of Toronto Monthly* 16 (1916): 220. On Macallum, see *Dictionary of Scientific Biography* (New York: Scribner 1973), vol. 8, 583–4; also PTRSC, 3 rd ser., vol. 28 (1934): xix–xxi.

15 Stanley B. Frost, *McGill University: For the Advancement of Learning*, vol. 2, *1895–1971* (Montreal: McGill-Queen's University Press 1984), 80–2.

16 Ibid., 177.

17 Ross, "Development of the Ph.D.," 292.

18 Ibid., 245. For further discussion of the AAU, see L. Veysey, *The Emergence of the American University* (Chicago: University of Chicago Press 1965), 175–7.

19 Frost, *McGill University*, 2:177.

20 Ross, "Development of the Ph.D.," 195.

21 W.P. Thomson, *Graduate Education in the Sciences in Canada* (Toronto: University of Toronto Press 1963).

22 Roy MacLeod, "The Endowment of Research Movement in Great Britain, 1868–1900," *Minerva* 9 (1971): 197–230.

23 Roy M. MacLeod and E. Kay Andrews, "Scientific Careers of 1851 Exhibition Scholars," *Nature* 218 (15 June 1968): 1012. On the financial aid program of the École pratique, see Craig Zwerling, "The Emergence of the École Normale Supérieure as a Center of Scientific Education in the Nineteenth Century," in R. Fox and G. Weisz, ed., *The Organization of Science and Technology in France, 1808–1914* (Cambridge: Cambridge University Press 1980), 45.

24 *Record of the Science Research Scholars of the Exhibition of 1851* (London 1930), 1.

25 Dalhousie University Archives, MS IS 4, Minutes of the Board of Governors, vol. 4, 8 Nov. 1892, p 226.

26 Ibid., 227.

27 Ibid.

28 Public Archives of Nova Scotia, MG 100, 182, no. 37, Application of James Gordon MacGregor for the Professorship of Natural Philosophy in the Edinburgh University, 1901, 4–5.

29 For further details of the career patterns of these students, see Y. Gingras, "Les Physiciens canadiens: généalogie d'un groupe social, 1850–1950" (Thèse de doctorat, Université de Montréal 1984), 93–6.

30 See also Y. Gingras, "Le Développement du marché de la physique au Canada, 1879–1928," in R.A. Jarrell and A. Roos, *Critical Issues in the History of Canadian Science, Technology and Medicine* (Thornhill: HSTC Publications 1983), 16–30.

31 The fourth conference of Canadian universities, in 1917, resolved to send a circular letter to the major British universities arguing that "[only with] the establishment of doctorates that may be obtained within a reasonable time ... can we hope that the stream of students which of late has set towards the United States, will be directed to the Universities of Britain." See "Fourth Conference of Canadian Universities, May 24–25, 1917," in *National Conference of Canadian Universities*, 63.

32 Harris, *History of Higher Education*, 315.

33 H.J. Cody, "A Chapter in the Organization of Higher Education in Canada, 1905–1906," *PTRSC*, 3 rd ser., vol. 40 (1946): sec. II, 98.

34 For further details of the evolution of the movement for industrial research, see Philip Enros, "The University of Toronto and Industrial Research in the Early Twentieth Century," in Jarrell and Roos, *Critical Issues*, 155–66; and Enros, "The Bureau of Scientific and Industrial Research and School of Specific Industries: The Royal Canadian Institute Attempt at Organizing Industrial Research in Toronto, 1914–1918," *HSTC Bulletin* 7, no. 1 (Jan. 1983): 14–26.

35 The events surrounding the establishment of the NRC are well discussed in Thistle, *The Inner Ring*.

36 Ibid., 9–12.

37 J.C. McLennan to R.A. Falconer, 9 Aug. 1916, cited in Ross, "Development of the Ph.D.," 274.

38 "Third Conference of Canadian Universities: McGill University, May 22 and 23, 1916," in *National Conference of Canadian Universities*, 23–4.

39 NRC Archives, Minutes of the First Meeting, December 4–6, 1916, Minute no. 21.

40 Thistle, *The Inner Ring*, 27.

41 *Annual Report of the NRC, 1917–18*, 38.

42 Ibid., 37.

43 Ibid., *1918–19*, 42.

44 These figures are compiled from annual reports of NRC, which include each year a list of award recipients, their research fields, and the universities where they worked.

45 A.B. Macallum to J.C. McLennan, 22 June 1918, cited in Thistle, *The Inner Ring*, 36.

46 "Fourth Conference of Canadian Universities," 52–9.

47 Ibid., 53. See also "Fifth Conference, 1918," 11; and "Eighth Conference, 1922," 52–9.

48 A.B. Macallum to Sir George Foster, 25 Aug. 1917, quoted in Thistle, *The Inner Ring*, 27.

49 On the situation at McGill, see Frost, *McGill University*, 2:177–81; and Thomson, *Graduate Education in the Sciences*, chap. 4.

50 Report of the Committee on Scientific Research, in *Annual Report of the Principal of Queen's University, 1916–17*, 30.

51 Ibid., 35.

52 Queen's University Archives, coll. 2400, box 2, A.L. Clark to G.Y. Chown, 23 March 1919.

53 See the remarks of Clark in Report of the Committee on Scientific Research, in *Annual Report of the Principal of Queen's University, 1926–27*, 47.

54 Queen's University Archives, Gray Papers, box 4, J.A. Gray to E. Rutherford, 27 Oct. 1926.

55 NRC, Minutes of the Fifth Meeting, May 12–21, 1917, 4.

56 Regulations Governing the Award for Grants for Research, *Annual Report of the NRC, 1917–18*, 30.

57 *Annual Report of the NRC, 1926–27*.

58 Y. Gingras, "Croissance de la recherche scientifique et transformation de la Section III de la Société royale du Canada," *Scientia Canadensis* 10, no. 1 (Spring 1986): 53–71.

59 See Gingras, "De l'enseignement à la recherche"; and Gingras, "The Institutionalization of Scientific Research at Canadian Universities: The Case of Physics," *Canadian Historical Review* 67 (1986): 181–94.