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Article abstract

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WOMEN IN CANADIAN SCIENCE AND TECHNOLOGY BEFORE WORLD WAR I: THEIR PUBLICATION RECORD¹

Clara M. Chu² and Bertrum H. MacDonald³

ABSTRACT

Little has been written about the work of women in Canadian science and technology, particularly for the period prior to the First World War. In this study, drawing largely on data in *Science and Technology in Canadian History: A Bibliography of Primary Sources to 1914*, we present a picture of the activity of almost 150 women authors. Representing 1.4% of all known authors of the period, these women wrote on a variety of scientific and technological topics and sometimes with a particular woman's viewpoint. The analysis highlights a number of changes which occurred throughout the nineteenth and early twentieth century.

RESUME

On connaît peu de choses de la place des femmes dans la pratique des sciences et de la technologie au Canada, particulièrement avant la première Guerre mondiale. Fondé sur le volume *Science and Technology in Canadian History: A Bibliography of Primary Sources to 1914*, cet article aborde cette question à partir de l'étude des activités d'environ 150 auteurs féminins. Représentant 1.4% de l'ensemble des auteurs répertoriés, ces femmes ont écrit sur une variété de sujets de nature scientifique et technologique, souvent à partir d'un point de vue féminin. L'analyse fait ressortir les principaux changements survenus dans la distribution des sujets abordés entre 1800 et 1914.

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INTRODUCTION

Little more than a decade ago, Prof Thomas H.B. Symons in his Report of the Commission on Canadian Studies wrote that not only do 'whole areas in the history of Canadian science remain unresearched and unwritten' but that 'research, publication and teaching in the history of the sciences is, in fact, one of the most underdeveloped fields of scholarship in Canada.'⁴ Although there have been a number of significant strides achieved over the past ten years, those involved in research and teaching the history of Canadian science and technology still note that few works have been published on the topic. The lack of historical analyses of the contributions of Canadians to science and technology is a major reason why many in this country are generally not aware of accomplishments in this field. In 1985, for example, Dr William McGowan, then Director of the National Museum of Science and Technology, commented that 'in his travels, he continually [found] evidence that even science teachers in Canada [drew] blanks when asked about key events in Canada's technical past.'⁵ If this situation is generally true for the complete discipline of the history of Canadian science and technology, it is more particularly the case with the role that women have played in this history -- receiving much less attention and being more poorly documented. Nevertheless, some steps have been taken to bridge the gap in historical treatment by

4 Thomas H.B. Symons, *To Know Ourselves: The Report of the Commission on Canadian Studies* (Ottawa, 1975), vol. I, 162, 163.

5 Wallace Immen, 'Museum is Seeking to Show Canadians 'Technological Past,' *The Globe and Mail*, 3 Dec 1985, A13.

such writers as Marianne Gosztonyi Ainley⁶, Diana Pedersen and Martha Phemister⁷, and the bio-bibliographical contribution by Philip C. Enros⁸. Other sources for information about the role of women in Canadian science and technology include articles in the periodicals *Scientia Canadensis*, *Signs* and *Resources for Feminist Research*. American studies (including the investigations of Aldrich, Alic, Kohlstedt, Rossiter and Schiebinger) are somewhat more developed and provide a richer source of information about the topic generally⁹. In addition, some treatment of early and modern women scientists is available in general historical works as well as bio-bibliographies¹⁰.

Most of the research on women in Canadian science and technology that has been done so far concentrates on the contribution of women after World War I. In this paper, however, we focus on women who participated in Canadian science and technology before the Great War. Our interest in pursuing this study was spurred by the availability of *Science and Technology in Canadian History: A Bibliography of Primary Sources to 1914* (hereinafter referred to as the *Bibliography*).¹¹ The publication of this research tool not only makes tracing of the history of the transmission of Canadian scientific and technological ideas before World War I possible, but also allows the study of the communication of scientific and technological information by women. In her work, Ainley noted that finding

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- 6 Marianne Gosztonyi Ainley, 'Canadian Women Natural Scientists 1900-1950. A Pilot Study,' paper read at the Fourth Kingston Conference on the History of Canadian Science and Technology, Kingston, Ontario, October 1985; Marianne Gosztonyi Ainley, 'Women Scientists in Canada: The Need for Documentation,' *Resources for Feminist Research* 15:3 (1986), 7-8.
 - 7 Diana Pedersen and Martha Phemister, 'Women and Photography in Ontario, 1839-1929: A Case Study of the Interaction of Gender and Technology,' *Scientia Canadensis* 4:1 (1985), 27-52.
 - 8 Philip C. Enros, comp., *Bio-bibliography of Publishing Scientists in Ontario Between 1914 and 1939* (Thornhill, Ont, 1985).
 - 9 See Appendix for a selective bibliography of studies on the history of American women in science and technology.
 - 10 Pnina G. Abir-Am and Dorinda Outram, eds., *Uneasy Careers and Intimate Lives: Women in Science, 1789-1979*, with a foreword by Margaret W. Rossiter (New Brunswick, NJ, 1987); Margaret Alic, 'The History of Women in Science: A Women's Studies Course,' *Women's Studies International Forum* 5:1 (1982), 75-81; Margaret Alic, *Hypatia's Heritage: A History of Women in Science from Antiquity to the Late Nineteenth Century* (London, 1986); Caroline L. Herzenberg, *Women Scientists from Antiquity to the Present: An Index: An International Reference Listing and Biographical Directory of Some Notable Women Scientists from Ancient To Modern Times* (West

names of publishing women scientists could be obtained by searching through primary literature but it was more difficult to obtain 'detailed information on the family background, education, and career opportunities of both successful and unsuccessful women scientists in Canada.'¹² The primary literature is, however, by itself an important source of information and it is on this type of data that our study is made. It needs to be stated that an analysis that depends primarily on one type of evidence will lead to a particular profile of past activities and people. Still, the portrait that develops is a window into the past and in the absence or paucity of other records it may be the only one possible. The Royal Society of London has declared that 'science rests on the published record.'¹³ Rossiter also recognizes bibliographies as tools which show the transmission of science and can be used to trace the history of women in science¹⁴. Our investigation which follows gives attention to the published record and no attempt is made to shed light on the role of women who did not publish.

METHODOLOGY

The data for this study was obtained from the database of the *Bibliography*. A wealth of data not readily available elsewhere was brought together in the *Bibliography* and, thus, facilitated the collection and analysis of data for this study.

We need to first define the parameters of the data examined which by virtue of their source mirror the same boundaries as the *Bibliography*: (1) only primary works, i.e., monographs and journal articles of the period, were examined, (2) Canadian science and technology were defined to include any scientific or technological work published in Canada or abroad by a Canadian and those works which had sufficient Canadian content published in Canada or abroad by a non-Canadian, (3) Canada was

12 Ainley, 'Women Scientists in Canada,' 7.

13 Royal Society Scientific Information Committee, *A Study of the Scientific Information System in the United Kingdom* (British Library R & D Report no. 5626, 1981), quoted in Denis Grogan, *Science and Technology. An Introduction to the Literature* (London, 1982), 4th ed., 14.

14 Margaret W. Rossiter, 'Women and the History of Scientific Communication,' *Journal of Library History*, 21:1 (1986), 40.

taken to mean the territory circumscribed by current national boundaries, (4) Science and technology were given a broad interpretation so that topics which might now be considered on the fringe or outside the field were included. Hence, geographical works (i.e., settlers' guides or descriptions of voyages and explorations) were included because of their natural history descriptions and/or their topographic or cartographic data. Except for those publications treating physiology or anatomy, medical works were excluded¹⁵, and (5) as stated earlier, the time period covered primary works published before 1914.

Women authors were identified by selecting appropriate names from the author catalogue of the *Bibliography*. This catalogue lists the authority (or standardized) name of each publishing author featured in the *Bibliography* and any variant name(s) by which the author may be known. A variant name acts as a 'cross-reference' directing a user to the authoritative form of an author's name where all the works by that author are listed. For example, all works by JULIAN DURHAM are grouped under the standardized heading HENSHAW, JULIA WILMOTTE, 1869-1937.

The process of identifying women authors was a task fraught with problems. For example, some first names are not sex-specific either currently or previously as in the case of such names as Leslie and Shirley. Name dictionaries were consulted to determine the usage of names¹⁶. For first names that could be used by either sex, we sought further information from either the author annotations in the bibliographic entries or biographic sources to provide us with enough information to accept or exclude a name from the list of women authors. Women who published under pseudonyms or who provided only initials rather than full first names, because they may not have wanted to be identified, have their work questioned, or face publishing problems, were difficult to determine unless the women were quite prominent and had already been so identified by name authority agencies or biographies. We made no attempt to try to identify the sex of authors of works published anonymously. The

15 The *Bibliography* does not include medical publications (except as noted) since other reference works have covered that area. See, for example, Charles G. Roland, *Secondary Sources in the History of Canadian Medicine: A Bibliography* (Waterloo, Ont, 1984), and Charles G. Roland and Paul Potter, *An Annotated Bibliography of Canadian Medical Periodicals, 1826-1975* (Toronto, 1979).

16 E.G. Whithycombe, *The Oxford Dictionary of English Christian Names* (Oxford, 1945); Charles Earle Funk, *What's the Name, Please? A Guide to the Correct Pronunciation of Current Prominent Names* (New York, 1936); C.O. Sylvester Mawson, *International Book of Names* (New York, 1942).

subject which authors were writing about sometimes helped us to determine the sex of an author with a 'nondescript' name. However, information on the exact time women began to publish in specific subject areas is not available, therefore, subject information often did not help resolve the problem.

After the list of women authors was finalized, all the works entirely authored or co-authored by each woman were extracted from the *Bibliography* for examination. To determine the subject of each work, the following method of analysis was used: 1) for monographs, the broad subject category which predominates in a work was taken to be the subject, and 2) for journal articles, the broad subject category of coverage of a serial or journal where an article was published was taken to be the subject, e.g., the subject of an article in the *Canadian Horticulturist* is HORTICULTURE. It should be remembered, as was noted earlier, that the subject range of science and technology is broad following that of the *Bibliography*.

To obtain further data on the women in the list, biographical sources and guides to manuscripts were checked. For example, a search of the *Union List of Manuscripts in Canadian Repositories*, using all the women's names, was conducted. Similar to the discovery of Ainley¹⁷ this strategy did not prove very fruitful. Our search for publicly available personal documents of the women authors in our study has yielded records for only ten women and biographical data is only available for thirty-six women. Because any thorough study of early women scientists and technologists has to include the primary literature, our analysis now takes a close look at what may be the only available public record of the contributions made by women in Canadian science and technology prior to the First World War.

RESULTS

After a manual search through the *Bibliography* and verification of uncertain authors, 145 women authors with 26 variant names (total=171) were revealed from 10,086 possible authors with 824 variant names (total=10,910). Women publishing on Canadian science and technology prior to 1914 constituted 1.4% of all authors (at least, all authors listed in

17 Ainley, 'Canadian Women Natural Scientists, 1900-1950,' op. cit.; Ainley, 'Women Scientists in Canada,' op. cit.

the *Bibliography*) publishing in that period. In comparison, Enros' *Bio-bibliography*¹⁸ reveals that in a subsequent period (1914-1939) in Ontario alone the percentage of women authors had increased to 8.8% (or 107 out of 1213 authors).

The list of women authors shows various styles of name usage. Women authors who used pseudonyms or first initials rather than full first names occur infrequently in our list because, as was noted earlier, it was not generally possible to identify the sex of authors using 'nondescript' names. Three pseudonymous names for women were discovered (ENA, Lady of the Principality and Sister of Charity) and one woman's name which used initials only for the first name (D'Anvers, N.) was found. Forms of address were quite useful in identifying 'nondescript' names, for example, twenty names used 'Mrs,' five names used 'Miss,' and one name used 'Countess' (i.e., Countess of Dalhousie).

he women authors wrote 248 works: 57 (or 23%) are monographs, and 191 (or 77%) are journal articles. This publishing pattern by women is different from all the authors identified by the *Bibliography* where 9.8% (5,690 of 58,109) of all works are monographs and 90.2% (52,419 of 58,109) are journal articles. Women published an average of two works in comparison to approximately three works per author for the total *Bibliography* (approximately 24,000 of the 58,109 works in the *Bibliography* were published anonymously and were not included in the analysis). While we have no

18 Enros, op. cit.

other studies with which to compare our findings on the publishing patterns of men and women scientists and technologists, for a later period Cole and Zuckerman found that 'more than 50 studies of scientists in various fields show that women publish less [about 50% less than men. Moreover, correlations between gender and productivity have been roughly constant since the 1920s.¹⁹ The same pattern seems to be evident in our data.

We turn now from an examination of general patterns to a closer inspection of the data. The earliest two monographs authored by a woman deal with scientific topics: the first by Lady of the Principality²⁰ in 1833 treated anthropological topics and the second by Anna Brownell Jameson²¹ in 1839 discussed anthropological and natural history subjects. The earliest two monographs authored by a woman on technological topics were published by Eliza Maria Jones in 1892 and 1893, and deal with dairying and animal husbandry²². The earliest two journal articles in the *Bibliography* found to be written by women were both published in 1829 and deal with scientific subjects: one by Countess Dalhousie on botany and the other by Mrs Harriet Sheppard²³ on invertebrates. In this regard, Ainley noted Lady Dalhousie (or Countess Dalhousie) as being 'the first recorded woman scientist in Canada . . . who, from 1816 (long before Catherine Parr Traill "discovered" the wildflowers of Ontario), collected plants in

19 Jonathan R. Cole and Harriet Zuckerman, 'The Productivity Puzzle: Persistence and Change in Patterns of Publication of Men and Women Scientists,' in Marjorie W. Steinkamp and Martin L. Maehr, eds., *Women in Science* (Greenwich, CT, 1984), 217. (Advances in Motivation and Achievement, v. 2).

20 Lady of the Principality, *The History of Wales: Containing Some Interesting Facts Concerning the Existence of a Welsh Tribe Among the Aborigines of America. Arranged as a Catechism for Young Persons* (Shrewsbury, 1833).

21 Anna Brownell Jameson, *Winterstudien und Sommerstreifereien in Canada* (Braunschweig, 1839), 3 vols.

22 Eliza Maria Jones, *Dairying for Profit; or, The Poor Man's Cow* (Montreal, 1892); Eliza Maria Jones, *Lecture on Co-Operative Dairying and Winter Dairying* (Montreal, 1893).

23 Harriet Sheppard published using the name 'Mrs Sheppard.' She was the wife of William Sheppard and one of the founders of the Literary and Historical Society of Quebec. Her name was confirmed in W. Stewart Wallace, *The Macmillan Dictionary of Canadian Biography* (Toronto, 1978), rev., enl., and updated by W.A. McKay, 4th ed.

Nova Scotia and Quebec for Kew Gardens in England.²⁴ The *Bibliography* shows the first woman writing on a technological subject was a Mrs Loudon, whose journal article published in 1849 deals with the 'Formation of Hot-Beds.' Works on technological topics written by women had a later start than those on scientific topics, especially those in monograph format (1849 for a journal article on a technological topic as compared to 1829 for a scientific journal article and 1892 for a monograph on a technological topic in contrast to 1833 for one on a scientific topic). Since many historical analyses of science and technology have often overlooked women, explanations that would account for the publishing pattern just outlined are not immediately evident. Cummins, McDaniel and Beauchamp have suggested that, at least as far as invention is concerned, there is a public/private element which delegates some of women's work, such as home-based or domestic inventions to the privacy of the home²⁵. The work of some women, therefore, remained hidden and only as such activities as domestic science became more established on their own right did technological work by women get into the public domain. While not conclusive this view may explain the later appearance of technological works by women in our study.

Although the *Bibliography* indicates that the first publication by a woman appeared in 1829, it was not until the mid-1870s that women were publishing yearly, and within the time period covered by the *Bibliography*, no more than thirteen works (journal articles and monographs combined) were ever published in any one year by women (e.g., thirteen publications in 1897 and twelve both in 1898 and 1912).

The subject areas which women were writing about are quite varied (See Tables 1 and 2). An analysis based on the subject content of monographs and journal articles showed that monographs dealt mainly with science while journal articles primarily treated technology. Only five of the fifty-seven monographs (8.8%) cover a technological topic while 126 out of the 191 journal articles (66%) treat technological topics. The scientific areas that were most written about are: natural history, anthropology (including archaeology, ethnology and the topic generally), travel, general science, and entomology. The technological topics which received the most attention are: agriculture (including animal husbandry, apiculture, horticulture

24 Ainley, 'Women Scientists in Canada,' 7.

25 Helene Cummins, Susan A. McDaniel and Rachelle Sender Beauchamp, 'Women Inventors in Canada in the 1980s,' *Canadian Review of Sociology & Anthropology* 25:3 (1988), 393.

and the topic generally), architecture and building and mining. Agriculture is the dominant topic of all the publications (118 out of 248 or 47.6%) and of the monographs that treat technological topics, all five deal with agriculture.

Most of the works were published in Canada (See Table 3). Forty-four percent (or 25 out of 57) of the monographs were published in Canada, predominantly in Ontario (sixteen works or 64% of works published in Canada), and 85.4% (or 41 out of 48) of the journals were published in Canada. Canadian journals account for 94.2% (or 180 out of 191) of the journal articles. Three works²⁶ were published in languages other than English: two are monographs (one in German published in 1839 in Germany and one in French published in 1894 in Canada) and one is a journal article on field and fodder crops published in 1860 in the only French language, Canadian journal that figured in our study, namely, *Agriculteur*²⁷.

Of those women authors whose place of birth or residence could be determined, 65.5% or 95 out of 146, were born or resided in Canada and of these most of them (55.2% or 53 out of 96) were from the province of Ontario. Foreign women authors writing about Canadian science and technology totalled thirty-five (or 24%), with twenty-six being American, eight

26 Eliza Maria Jones, *Laiterie payante, ou, La vache du pauvre* (Trois-Rivières, 1894); Jameson, op. cit.; Cora Elisabeth (Robinet) Millet, "Du paturage du trèfle et de la luzerne," *Agriculteur; journal officiel de la Chambre d'agriculture du Bas-Canada* 13:3 (1860), 56-8.

27 Although *Agriculteur* was the only French Canadian language journal that figured in our study, other French Canadian language journals appear in the *Bibliography*, such as *Le Naturaliste canadien* and *Abeille canadienne, journal de littérature et de sciences*.

British and one Mexican. The place of origin of fifteen women authors could not be determined with certainty but it is probable that the majority were of Canadian origin.

Most of the women did not receive higher education. Only seventeen (or 11.6%) were identified as having some university education which may or may not have led to degrees. Eight of these were American²⁸, nine were Canadian:

Baker, Emma Sophia, BA (Victoria University, 1899),
PhD (Toronto, 1903; psychology)

One of the first of two women upon whom was conferred a PhD from the University of Toronto. The title of her doctoral thesis is 'Experiments on the aesthetic of light and colour: On combinations of two colours.'²⁹ Her journal publications similarly describe experiments on the aesthetic of light and colour.

Benson, Clara Cynthia, BA (University College, 1899;
honours in physics and chemistry), PhD (Toronto, 1903; chemistry)

One of the first of two women upon whom was conferred a PhD from the University of Toronto. The title of her doctoral thesis is 'The rates of reac-

28 Katharine Jeanette Bush (b 1845) received the first doctorate in zoology awarded to a woman by Yale University in 1901. Anna Botsford Comstock (1854-1930), an entomologist, received a BS from Cornell University in 1885 and an honorary doctorate from Hobart College, Geneva, NY. She also became the first woman on faculty at Cornell University (Dept of Entomology). Ruth Holden (1890-1917), a botanist, was a student at Radcliffe College. Carlotta Joaquina Maury (1874-1938), a geologist, studied at Radcliffe College and University of Paris, and received a PhB in 1896 and a PhD in 1902, both from Cornell University. Ida Helen Ogilvie (1874-1963), a geologist, received an AB (1896 or 1900) from Bryn Mawr College and a PhD in 1903 from Columbia University. Jennie Maria (Arms) Sheldon (b 1852), a geologist, was a special student at MIT between 1877 and 1881 for at least two years and also a special laboratory student at the Boston Society of Natural History. Erminnie Adele Smith (1836-1886), an anthropologist, graduated from Emma Willard's Troy Female Seminary (New York) in 1858, also studied in Germany and won the undergraduate prize for geology and mineralogy at Vassar College. Anna Murray Vail (b 1863), a botanist, studied privately and predominately in Europe.

29 Judy Mills and Irene Dombra, *University of Toronto Doctoral Theses, 1897-1967* (Toronto, 1968), 131.

tions in solutions containing ferrous sulphate, potassium, iodine and chromic acid.³⁰

Brooks, Harriet, BA (McGill, 1898; gold medal in mathematics and physics), MA (McGill, 1901)

Chown, Susannah Amelia, BA (Toronto, 1907?)

Derick, Carrie Matilda, BA (McGill, 1890; gold medal in natural science), MA (McGill, 1896)

Fyles, Faith, BA (McGill, 1900; botany)
Fyles was a student of Carrie M. Derick.

Macleod, Annie Louise, BA (McGill, 1904; 1st class honours in chemistry), MSc (McGill, 1905), PhD (McGill, 1910; chemistry)

Menten, Maud Lenora, BA (Toronto, 1904), MB (Toronto, 1907), MD (Toronto, 1911), PhD (Chicago, 1916; biochemistry, with Albert Prescott Mathews)³¹

Young, Rosalind Watson, BA (McGill, 1895; gold medal in natural science), MA (McGill, 1901)

If the 145 women authors in our study, three (Annie L. Jack, Catherine Parr Traill and Henrietta F. Buller) were the most prolific. Annie L. Jack published twenty-nine journal articles between 1877 and 1911, all on horticulture. Catherine Parr Traill contributed seven monographs and four journal articles between 1855 and 1906 on botany. Henrietta F. Buller brought out nine journal articles between 1886 and 1893 on apiculture. Not all women were as prolific as these, a few published three or four works, but most published only one.

Although most women published as sole authors (81.4% or 118 out of 145), 27 of the 145 women authors (18.6%) published jointly with others. Eight

30 Mills and Dombra, op. cit., 24.

31 Further discussion on Menten's work is found in John Walkley and Chris Hewer, 'Maud Leonora Menten: Her Contributions to Biochemistry,' paper read at the Fifth Kingston Conference on the History of Canadian Science and Technology, Ottawa, Ontario, October 1987. *The National Union Catalogue Pre-1956 Imprints* provides two spellings of Menten's middle name, Lenora and Leonora.

women co-authored with other women and nineteen women published with men. Thirteen of the women authors who collaborated with men were the principal authors and in only six cases were they secondary authors. Authorship considered in a broad sense does not necessarily imply active work in science and technology, thus, not all women who contributed to Canadian science and technology prior to 1914 were scientists and technologists per se, four were translators, one was an illustrator and one wrote the biographical introduction to a work by James Cook. Those women who worked in fields closely allied to the science and technology professions included: sixteen educators, four museum or laboratory assistants, six literary authors, three journalists, four members of the editorial boards of journals and one secretary of an horticultural association³². Nine of the educators who had higher education were teaching in post-secondary institutions and were in a position to be active researchers.

A number of studies have found that women associated with men who were established scientists not only raised their interest in scientific pursuits but also gave some women entry into the field³³. Nine women in our study were related to famous men³⁴.

As an additional characterization of the publishing record, it is worth noting that some women brought their own perspective to their writing or

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- 32 The educators were Emma Sophia Baker, Clara Cynthia Benson, Harriet Brooks, Anna Botsford Comstock, Mattie Rose Crawford, Clara Eaton Cummings, Carrie Matilda Derick, Elizabeth Frame, Clara E. (Speight) Humberstone, Margaret Macdonald, Annie Louise Macleod, Carlotta Joaquina Maury, Maud Lenora Menten, Ida Helen Ogilvie, Mary McKay Scott and Jennie Maria (Arms) Sheldon. The assistants include Katharine Jeanette Bush and Alice Cunningham Fletcher who were museum assistants, Faith Fyles who assisted a Dominion botanist and Annie L. Saunders who worked at the Central Experimental Farm (Ottawa). The literary authors were Marie Adelaide Brown, Helen Mar Johnson, Helen M. Merrill, Susanna Moodie, Amelia MacLean Paget and Catherine Parr Traill. The journalists include Julia Wilmotte Henshaw, Ella Cora Hind and Rosalind Watson Young. Women on editorial boards were Alice Cunningham Fletcher, Mary Basset Hodges, Mary McKay Scott and Anna Murray Vail. Helen Henman was secretary of the Thornbury Horticultural Society (Ontario).
- 33 Abir-Am and Outram, op. cit.; Lois Barber Arnold, *Four Lives in Science: Women's Education in the Nineteenth Century* (New York, 1984); Sally Gregory Kohlstedt, 'In from the Periphery: American Women in Science, 1830-1880,' *Signs* 4:1 (1978), 81-96; Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, 1982).
- 34 The nine women included Henrietta F. Buller, wife of Edmund R. Buller (writer on apiculture); Anna Botsford Comstock (1854-1930) was married to John Henry Comstock (1849-1931), an entomologist; Countess of Dalhousie, wife of George Ramsay,

wrote specifically for a female audience. For example, four works described travel, geography, natural history and ethnology from a woman's outlook, and one work described a visit to a peat bog as experienced by a woman. A Mrs Townsend wrote about a woman's experience raising poultry³⁵. Elsie A. Dent published 'Women's Work in Astronomy' in 1902³⁶. Moreover, there were six periodical articles which introduced possible occupations for women, for example, three works dealt with apiculture for women (excluded from this count is a work by a M. Treverrow because the sex of this author could not be determined), and three works dealt with horticulture for women. Rossiter's study of American women's work in science between 1880 and 1910 found that many middle-class magazine articles (many written by women) also hailed new opportunities for women³⁷. However, the newest areas of women's work were in low-ranking and low-paying scientific or in low-paying social service positions, which is not demonstrated by our data. The publications in our study that we have noted above highlight women's experiences outside the home, accounts of their own contributions in science and successes in agricultural pursuits.

DISCUSSION

A number of writers, who have examined the activities of women in science and technology in other countries, have developed models to describe the patterns that they saw. For example, in her analysis of American women in science between 1830 and 1880, Sally Kohlstedt³⁸ used three divisions: the first generation, or 'independents,' are those women who worked autonomously, and whose efforts did not receive much attention, the second generation was made up of mid-nineteenth-century American women who popularized and disseminated science, such as educators and illustrators and the third generation consisted of

35 Mrs Townsend, 'A Woman's Experience,' *Canadian Bee Journal Weekly and Poultry Weekly* 5:16 (1889-90), 361.

36 Elsie A. Dent, 'Women's Work in Astronomy,' *Royal Astronomical Society of Canada. Selected Papers and Proceedings* 13 (1902-3), 122-40.

37 Margaret W. Rossiter, ' "Women's Work" in Science, 1880-1910,' *ISIS* 71:258 (1980), 383.

38 Kohlstedt, op. cit.

American women who had to choose between amateur activities and a professional career. Women's acceptance into the scientific world was a form of occupational sex segregation³⁹. Arnold notes that although 'by the turn of the twentieth century, American women had gained scientific educations that enabled them to be incorporated into the world of scientific employment, . . . they were segregated within that world.'⁴⁰ There were two kinds of segregation: (1) 'hierarchical' where women worked as assistants to scientists, who were mainly male, and (2) 'territorial' where women were working only in a particular field, namely, the sex-typed field of home economics or domestic science. While these categories of American women are not entirely congruent with the Canadian situation, they can serve as a guide in analysis of women's contributions to Canadian science and technology prior to the First World War.

For our Canadian data, our 'first generation' of women contributed to science through their writings in natural history, ethnology and geography of different areas of Canada, which were the results of travels, usually taken with men (for example, Lady of the Principality and Anna Brownell Jameson). These first generation of women who were mainly naturalists and observers did not have higher education but did record their observations.

Our 'second generation' of women who contributed to both science and technology consisted of educators, journalists, translators, illustrators, assistants in museums and literary authors, who wrote popular science works and textbooks, and included such authors as Catherine Parr Traill, Julia Wilmotte Henshaw and Agnes D. Chamberlin (Fitzgibbon). In this regard, these women correspond to Kohlstedt's definition of 'second generation' popularizers of science.

The 'third generation' of women make up the majority of women in our study. They are comprised of two categories. First, were amateurs con-

39 Arnold, op. cit.; Rossiter, 'Women Scientists in America,' op. cit.

40 Arnold, op. cit., 134.

tributing to technology, especially to agricultural topics⁴¹. For example, Annie L. Jack who wrote on horticulture, and Henrietta F. Buller and Ethel Robson who wrote on apiculture. Most of these women belonged to horticulture or apiculture associations. Second, were professionals who were teaching in universities and colleges or were assistants in museums or laboratories, most having higher education. Some of these women belong to Kohlstedt's third generation. All of the nine Canadian women listed earlier who obtained higher education, with the exception of Carrie M. Derick, Emma Sophia Baker, Clara Cynthia Benson and Annie Louise Macleod, became popularizers of science and technology or took up amateur activities once they married. For example, Rosalind Watson Young, who had an MA and was a teacher before marriage, published mining and geographical works as an amateur. An interesting case is that of Annie L. Jack who was a teacher until she married a fruitgrower and probably would not have contributed so extensively to horticulture if she had not married.

Our analysis of the data contained in the author annotations⁴² of the record(s) of each woman in the *Bibliography* provide some information about the educational and employment opportunities for women at the time and their affiliations in amateur, learned or professional societies. Earlier we noted that the positions held by women varied, including educators, literary authors and housewives. Employment opportunities for women in Canada in the mainstream of scientific and technological research seem to be few before 1914. At the turn of the century when

41 Ainley's definitions for amateur and professional ornithologists have been adopted and slightly modified for this study. An amateur is 'any author publishing . . . but having no institutional affiliation or financial support for research from any official source.' A professional is any person occupied with scientific and technological study, having institutional affiliation with universities, museums, federal or state departments, or equivalent, and contributing to science and technology. See Marianne Gosztonyi Ainley, 'The Contribution of the Amateur to North American Ornithology: A Historical Perspective,' *Living Bird* (1979/80), 168.

42 Author annotations in the *Bibliography* were created using biographical information contained in the publications that authors' or publishers' included.

women were able to demonstrate their capabilities through educational achievements, some were able to join the professional ranks. Post-secondary education was not available to Canadian women until the 1860s and only partial programmes of study were available at this time. Not until February 1885 were women admitted to study at the University of Toronto, although they had been allowed to take matriculation examinations from 1877 onwards⁴³. At McGill University, co-education began in 1884⁴⁴ while Mount Allison College already had its first graduate, Grace Annie Lockhart, who while not figuring in this study, received a BSc in 1875⁴⁵. Carrie Matilda Derick in 1891 became the first woman on staff at McGill University with the position of demonstrator in botany, in 1896 she became a lecturer, in 1906 she became an assistant professor in botany, and later went on to become the first woman full professor at a Canadian university.

Most of the women of our 'third generation' participated in local amateur associations and those who worked professionally belonged to scientific or learned societies, some of these were for women only. Membership in technological associations was limited to horticultural and apicultural societies but such affiliation seems to have influenced women to publish.

CONCLUSION

The above analysis provides a picture of the work of women in Canadian science and technology prior to 1914. From the publishing record we can characterize their contribution to the communication of scientific and technical information. Women authors, for example, made up 1.4% of all currently known authors of works on Canadian science and technology of the period. In terms of subjects, topics such as geography, natural history, anthropology, botany and agriculture predominated. Through publications on these issues women had an important role in popularizing science and technology. While limited access to educational and employment opportunities no doubt prevented more extensive contributions to the field, the publishing record establishes that the work of women should not be overlooked. In the growing field of science and

43 'Girls and Women,' in Charles E. Phillips, *The Development of Education in Canada* (Toronto, 1957), chapter 20, 375-86.

44 John William Dawson, *Report on the Higher Education of Women* (S.l., 1884?).

45 Ainley, 'Canadian Women Natural Scientists, 1900-1950,' 5. Other women who did not figure in our study are: Harriet Starr Stewart, MA (Mount Allison College, 1883) and Augusta Stowe, MD (Victoria College, 1883).

technology many women may have been on the periphery, yet their work was important in making science and technology available to the public-at-large and specifically to women.

A bibliographic analysis of the primary literature, as we have provided, furnishes one window on the activity of women in Canadian science and technology prior to 1914. This analysis while revealing in its own right (whether or not other primary literature, i.e., personal documents, are available), calls for further research that will include a study of the work of other women whose chief contribution was not through publication.

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TABLE 1 - Characterization of Monographs

A. Subject Content

Scientific Topics	
Anthropology - General	3
Anthropology - Archaeology	2
Anthropology - Ethnology	7
Botany	15
Mathematics	1
Natural History	2
Physics	1
Science - General	2
Travel *	16
Zoology	2
Technological Topics	
Agriculture	5
General Topics	
Societies/Associations	1
TOTAL	<hr/> 57

B. Format

Textbooks **	
- mathematics	1
- natural history	2
- pathology	1
TOTAL	<hr/> 4

C. Language

French	1
German	1

* Monographs on "Travel" include descriptions of journeys or explorations and settlers' guides which include natural history, geology, anthropology, geography, etc. of an area.

** Refers to the number of textbooks out of the total 58 monographs.

TABLE 2 - Characterization of Journals

A. Subject Content

	No. of Journals	No. of Articles
Scientific Topics		
Anthropology - General	1	1
- Archaeology	1	2
Astronomy	3	3
Biology - General	2	2
Botany	7	7
Chemistry	2	2
Geology	1	3
Natural History *	4	21
Physiology	1	1
Psychology	1	3
Science	5	14
Zoology - Entomology	2	6
Technological Topics		
Agriculture - General	4	14
- Animal Husbandry	1	1
- Apiculture	2	26
- Horticulture	3	72
Architecture and Building	3	4
Engineering	1	1
Mining	2	4
Patents	1	1
Technology - General	1	3
TOTAL	48	191

B. Journals Not Published in Canada

Foreign journals (from the total)	7	11
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C. Language

French (Canadian publication)	1	1
*Includes literary and historical journals which published articles on natural history among other topics.		

TABLE 3 - Place of Publication

A. Monographs

	No. of Monographs
Canada	25
- Ontario/Canada West (16)	
- Quebec/Canada East (9)	
United Kingdom	16
United States	11
Unknown	4
Germany	1
TOTAL	<hr/> 57

B. Journals

	No. of Journals
Canada	41
United States	5
United Kingdom	2
TOTAL	<hr/> 48

APPENDIX

History of American Women in Science and Technology:
A Selective Bibliography

Michele L. Aldrich, 'Women in Science,' *Signs* 4:1 (1978), 126-35.

Lois Barber Arnold, *Four Lives in Science: Women's Education in the Nineteenth Century* (New York, 1984).

Sheila Bertram, comp., *Women in Pure and Applied Science Bibliography* (Edmonton, 1987).

- This bibliography of approximately 2,500 items includes Canadian coverage, primarily of works on modern women in Canadian science and technology. It is frequently updated and may be obtained by writing to Dr Sheila Bertram, Faculty of Library and Information Studies, University of Alberta, Edmonton, Alberta (Canada) T6G 2J4.

Dortha Bailey Doolittle, 'Women in Science,' *Journal of Chemical Education* 22:4 (1945), 171-4.

Sally Gregory Kohlstedt, 'In from the Periphery: American Women in Science, 1830-1880,' *Signs* 4:1 (1978), 81-96.

Judith A. McGaw, 'Women and the History of American Technology,' *Signs* 7:4 (1982), 798-828.

Margaret W. Rossiter, 'Women Scientists in America Before 1920,' *American Scientist* 62:3 (1974), 312-23.

Margaret W. Rossiter, 'Sexual Segregation in the Sciences: Some Data and a Model,' *Signs* 4:1 (1978), 146-51.

Margaret W. Rossiter, ' "Women's Work" in Science, 1880-1910,' *ISIS* 71:258 (1980), 381-98.

Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, 1982).

Margaret W. Rossiter, 'Women and the History of Scientific Communication,' *Journal of Library History* 21:1 (1986), 39-59.

Londa Schiebinger, 'The History and Philosophy of Women in Science: A Review Essay,' *Signs* 12:2 (1987), 305-32.

Patricia Joan Siegel and Kay Thomas Finley. *Women in the Scientific Search: An American Bio-Bibliography, 1724-1979* (Metuchen, NJ, 1983).

Deborah Jean Warner, 'Women in Science in Nineteenth Century America,' *Journal of the American Medical Women's Association* 34:2 (1979), 59-66.